



Livestock Crate Design required to improve animal welfare during transport

Prepared for the Ministry for Primary Industries by Animal Welfare Solutions Ltd

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Report prepared for MPI

405753 - Livestock Crate Design Required to Improve Animal Welfare During Transport

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List of Abbreviations

Abbreviation	Definition
ACC	Accident Compensation Corporation
ALRTA	Australian Livestock and Rural Transporters Association
EFSA	European Food Safety Authority
EC	European Commission
FAWC	Farm Animal Welfare Committee
HLI	Heat Load Index
LCT	Lower Critical Temperature
MPI	Ministry for Primary Industries
NAWAC	National Animal Welfare Advisory Committee
NLTSG	National Livestock Transport and Safety Group
NZLTA	New Zealand Livestock Transport Assurance
THI	Temperature Humidity Index
UCT	Upper Critical Temperature
WHSQ	Workplace Health and Safety Queensland

1. Executive Summary

Livestock are transported by road for a range of reasons including moving animals between farms for sale or breeding, for fattening and access to better feed. The livestock transport industry is an essential part of the supply chain for meat production and the management of animal welfare through to the slaughter process. Therefore, it is important for New Zealand (NZ) that the industry operates in accordance with animal welfare and environmental standards and meets consumer expectations to remain a sustainable practice.

There has been a substantial body of research assessing the welfare of livestock during transport and there are many factors that can negatively impact on animal welfare, with heat stress, for example, being a significant welfare concern in hot, humid conditions. However, most research has been undertaken overseas under different conditions to NZ and relatively few studies have investigated the specific crate design.

The aim of this research project was to determine the necessary design features of NZ livestock crates to ensure they are fit for purpose and comply with the Code of Welfare: Transport within New Zealand (the transport code of welfare) and the Animal Welfare (Care and Procedures) Regulations; as well as compliance with the Health and Safety at Work Act 2015. A scientific literature review and a review of relevant standards in NZ and overseas was conducted, and findings are outlined in this report. This report also discusses how animal welfare is assessed and identifies risk factors associated with road transport, including heat stress and risks related to stationary periods when airflow is minimal.

A discussion outlining the findings from stakeholder engagement is also included. Stakeholder engagement included four workshops (two in the North Island and two in the South Island) and other meetings with transport operators, drivers, meat processors, livestock industry bodies and crate manufacturers to gain their insights and gather as much practical input into the research as possible. During the workshops, we encouraged discussions around how the current crate designs help to meet the current industry and government requirements related to animal welfare, which crate design features could be improved to protect animal welfare and driver safety, and the challenges and opportunities.

The key features of NZ livestock crate design that impact on animal welfare are discussed including ventilation, space allowances, ramps, flooring and shelter. Current designs have multiple deck configurations and deck heights designed to accommodate multiple species of different ages; however, the different livestock species being transported have different behavioural and physiological needs. Therefore, this 'one size fits all', multi-purpose design may fail to meet species-specific needs.

Some of the issues with the current crate designs identified included insufficient ventilation and head space, depending on the deck configuration, to allow sufficient airflow and meet requirements for animals to adopt 'normal' postures. Steep internal ramps, some flooring surfaces and the inability for covers to protect animals from weather extremes also make it difficult to meet current standards.

Due to NZ livestock crates having a relatively long life span (approximately 20 years), there are a variety of livestock crates on NZ roads and incremental changes to crate designs have been implemented over recent years. However, these appear to have been mainly driven by the need to reduce transport costs and comply with regulations (e.g., effluent management, back rub), with the aesthetic appearance of the crate also a consideration. There has been little or no scientific evaluation of current crate usage and designs, or recent modifications, and their effect on the crate environment and animal welfare. Furthermore, both government and industry standards are out of step with current science and current crate design and use.

It is unlikely that continuing to invest in small incremental changes, within the limits of the current crate design, will provide significant improvements for animal welfare or driver safety. It is also clear there are wider issues associated with meat companies' procurement processes and the wider supply chain that pose risks to animal welfare, driver safety and sustainability of the industry that cannot be eliminated through improved crate design alone. Therefore, this research is only one part of a larger puzzle.

Findings from this research support the case for reviewing current livestock crate guidelines and related industry and government animal welfare standards to reflect current scientific knowledge. Further research is also recommended to inform development of science-based standards and guidelines for livestock crates. These standards must be based on an understanding of the different needs for each livestock species being transported.

A One Welfare approach is recommended to ensure meaningful improvements are made for animal welfare and driver safety, as well as meeting expectations around carbon emissions and environmental requirements. There needs to be more accountability across the supply chain to meet livestock welfare standards and regulations during transport and create an even playing field. Many transport operators reported that their industry operates on extremely tight margins, and for a significant portion of their work meat companies dictate the cartage prices.

This research marks the initial phase in gathering essential information to guide long-term initiatives for improving animal welfare during transport in NZ. These efforts will require a proactive approach by the industry and collaborative action from a wide range of stakeholders, including all participants across the supply chain. Strategies to address issues meeting the current animal welfare standards and to future proof the design of NZ livestock crates will need to be developed.

System level changes across the entire supply chain are required to ensure sustainability of the transport industry in NZ, with achievement of better crate design being a critical part of this. Due to the complexity and challenges associated with these issues, and to ensure collective action is taken, it is suggested a formalised, action group could be established to develop and implement a tangible work programme. This could be delivered over the next three to five years or an appropriate timeframe determined by industry.

2. Introduction

Livestock are transported by road for a range of reasons including moving animals between farms for sale or breeding and access to better feed. However, in NZ, the largest numbers are transported to meat processors for slaughter. The livestock transport industry is therefore an essential part of the supply chain for meat production and the management of animal welfare through to the slaughter process.

The livestock transport industry is operated within a unique supply chain involving the farmer, stock agents, transport operators, meat companies and saleyards, and the responsibility for the animals therefore changes as they move from farm to farm, farm to sale, and farm to processing.

The red meat sector generates \$12 billion in income per year and is NZ's second largest goods exporter¹. There are approximately 60 meat processing plants within NZ, and approximately 2.3 million cattle, 20 million sheep, 1.5 million pigs, 430,000 deer and 155,000 goats are slaughtered annually. The meat processing industry is highly competitive, and the major companies have processing plants located across the country.

In NZ, there are no regulatory limits to the duration or distance livestock can be transported, except for young calves that can't be transported longer than 12 hours. This allows meat companies to transport livestock according to their procurement schedules to ensure plant capacity and meet operational needs. Therefore, livestock are often transported long distances, including Cook Strait ferry crossings, to meet these procurement requirements.

Multiple regulatory frameworks apply to livestock transport, including road regulations, driver fatigue management, animal welfare, and local and regional council requirements. It is important for NZ that the industry operates in accordance with animal welfare and environmental standards and remains sustainable. This is reflected in the regulatory requirements for animal welfare during transport in Europe, Australia, NZ and elsewhere, which differ across species and modes of transport.

Globally, over recent years, there has been an increase in societal and consumer awareness of animal welfare issues and pressure on livestock industries to provide animals with 'a life worth living', including during transport and slaughter². For example, Buddle et al. (2018) reported that meat consumers in Australia expressed concerns about livestock welfare during transport and suggested that the livestock transport sector has to some extent lost consumer trust.

¹ [MIA – We're the voice of New Zealand's red meat processors, marketers and exporters.](#)

² e.g. in response to the European Commission undertaking a comprehensive evaluation of the European Union (EU) animal welfare legislation under its Farm to Fork Strategy, including Council Regulation (EC) No. 1/2005, five independent scientific opinions on the protection of animals during transport were published at the request of the European Food Safety Authority (EFSA) in 2022. The differing transport requirements developed for each species, including pigs, cattle and small ruminants (sheep and goats), reflects the multiple factors influencing animal welfare for each species.

Similarly, in 2020, the European Union launched a committee of inquiry into livestock transport conditions following concerns raised about animal welfare^{3,4}. It concluded with members of the European Parliament voting overwhelmingly in favour of farm animals being better protected during transport and adopting a number of recommendations⁵. The violations that were determined in the case included lack of head room, food and water supply, livestock being unfit for transport and overcrowding. Such initiatives will further increase pressure on other countries to ensure high welfare standards during transport to maintain market access.

There has been a substantial body of research assessing the welfare of livestock during transport and there are many factors that can negatively impact on animal welfare. However, most research has been undertaken overseas, with only a few studies investigating environmental conditions in NZ livestock crates (Dobbinson 2020; Fisher et al 2004; Fisher et al 2002; Stewart et al 2010).

There have also been relatively few studies that have investigated the specific vehicle design or design aspects of the containers or livestock crates themselves. Importantly, the design of transport vehicles and crates overseas, as well as the weather and road conditions, are different to NZ, therefore caution is required when relating findings from overseas to NZ conditions.

A particular concern in livestock transport is heat stress. Heat stress and smothering pose significant welfare concerns during road transport and can lead to morbidity and high mortality rates. Livestock are most at risk of heat stress when vehicles are stationary and air flow is minimal (e.g., during driver rest stops, on interisland ferries, waiting to unload at meat processing plants).

NZ has a largely temperate climate with, for example, sub-tropical areas in the North Island and snow and freezing conditions common during winter in the South Island. The weather conditions can be extreme and can change very rapidly across the country. Extreme weather events such as extended periods of rain, storms and drought are also becoming more common, and the frequency of such events is expected to increase with climate change. This suggests that the risks of heat stress in livestock during transport are likely to increase.

Some design improvements, particularly to reduce back rub, have been implemented since research into welfare impacts of livestock transport was undertaken in NZ over 20 years ago. However, no improvements have been made to reduce the risk of heat stress. Conversely, over recent years, the ventilation gaps in many modern crate designs have been reduced.

The livestock crates currently used in NZ are designed according to the 1993 (NZS 5413) Code of Practice for the Manufacture and Use of Stock Crates on Heavy Vehicles. There have been changes in a number of areas which mean that this standard does not reflect current

³ [Animals must be better protected during transport | News | European Parliament \(europa.eu\)](https://www.europa.eu/press-room/en/infographic-animals-must-be-better-protected-during-transport)

⁴ [REPORT on the investigation of alleged contraventions and maladministration in the application of Union law in relation to the protection of animals during transport within and outside the Union | A9-0350/2021 | European Parliament \(europa.eu\)](https://www.europa.eu/press-room/en/infographic-report-on-the-investigation-of-alleged-contraventions-and-maladministration-in-the-application-of-union-law-in-relation-to-the-protection-of-animals-during-transport-within-and-outside-the-union)

⁵ [Texts adopted - Protection of animals during transport - Thursday, 20 January 2022 \(europa.eu\)](https://www.europa.eu/press-room/en/infographic-texts-adopted-protection-of-animals-during-transport)

legislation, current livestock and transport industry characteristics, or current animal welfare science and expectations, as follows:

- the NZS 5413 standard refers to the Animal Protection Act 1960 and other legislation around road restrictions from the 1960s and 1970s. It needs to reflect the Animal Welfare Act 1999 and subsequent amendments, new regulations and codes of welfare;
- increased public/consumer expectations around animal welfare;
- pressure on the industry to meet other requirements/regulations (e.g., environmental requirements);
- changes to livestock crate designs (e.g., increased pen heights to reduce back rub and improvements for driver safety);
- supply and demand factors have seen livestock travel greater distances associated with procurement processes and the nature of the supply chain; and
- an increase in the size of animals being transported, partly due to selection for increased growth.

These key changes mean that it is unlikely that the NZS 5413 standard protects animal welfare, as was originally intended. In fact, the newer designs have the potential to exacerbate the issues identified. Dobbinson (2020) suggests that the design of NZ livestock crates have reached their capacity to provide adequate pig welfare during transport and since it is expected that animals will become larger over time, future crate designs will need to be modified.

It is anticipated that the livestock transport industry will initiate a review of the NZS 5413 standard and this will be progressed in the near future. The National Animal Welfare Advisory Committee (NAWAC) also plans to initiate a review of the transport code of welfare within the next two years.

With these reviews planned, MPI determined that a comprehensive research project was required to obtain design specifications for livestock crates that are animal centric, while incorporating environmental factors and human health and safety considerations, to ensure they are fit for purpose and animal welfare and human safety are not compromised.

This report describes the research and refers to the key changes above. The proposed next steps are provided in the relevant sections of the report and are collated in Section 11.

Stakeholder engagement

Stakeholder engagement included discussions with transport operators, drivers, meat processors, livestock industry bodies and crate manufacturers undertaken throughout the project during online and face-to-face meetings, attendance at various livestock industry meetings and a series of workshops facilitated by Animal Welfare Solutions Ltd. We also gained valuable insights from shadowing some drivers, visits to processing plants and meeting with MPI Verification Services (VS) veterinarians.

During the workshops, we discussed how the crate designs help to meet the current standards and requirements related to animal welfare set out the industry standards listed below, and the transport code of welfare and regulations in regards to seven main areas; ventilation, space, covers, shelter, flooring and ramps, health and safety. Discussions included which design features could be improved to meet the standards and the challenges and opportunities to improve welfare and driver safety.

Throughout the report, some information from discussions with stakeholders are included in the relevant sections. The key findings from stakeholder engagement and the workshops are outlined in Section 8.

Key industry standards referred to throughout the report

- Code of Practice for the Manufacture and Use of Stock Crates on Heavy Vehicles, NZS 5413, 1993.
- New Zealand Livestock Transport Assurance (NZLTA) Programme Manual, 2017.
- Ia Ara Aotearoa Transporting NZ/National Livestock Transport and Safety Group (NLTSG), Stock Crate Code for Transportation of Livestock, 2021.
- DeerQA Transport Programme Manual, 2019.

3. Objectives

The aim of this research was to determine the necessary design features of livestock crates to ensure they are fit for purpose and comply with the transport code of welfare and the Animal Welfare (Care and Procedures) Regulations; as well as compliance with the Health and Safety at Work Act 2015.

4. Assessing animal welfare during road transport

A framework for assessing animal welfare

Societal concerns and how we assess animal welfare can be grouped into three overlapping categories that reflect how different people tend to emphasise different concerns, and our understanding of animal welfare is both values- and science-based (Fraser, 2008). These categories are:

- 1) Health and biological functioning, meaning that animals should function well in the sense of good health (e.g., free of disease and injuries), and normal growth and development;
- 2) Affective state, which describes how the animal is feeling (i.e., not in pain or distress); and
- 3) Natural living, meaning that animals should be able to engage in normal behaviours they are highly motivated to do within an environment.

Figure 1 uses this framework to highlight some of the factors animals can be exposed to during transport that can impact on their welfare. When animals lose the ability to control their environment, there are risks to their welfare that may not necessarily be linked to direct biological functioning. For example, during transport, an animal may be highly motivated to seek water, avoid body contact or seek shade to reduce body temperature and prevent dehydration but is prevented from doing so.

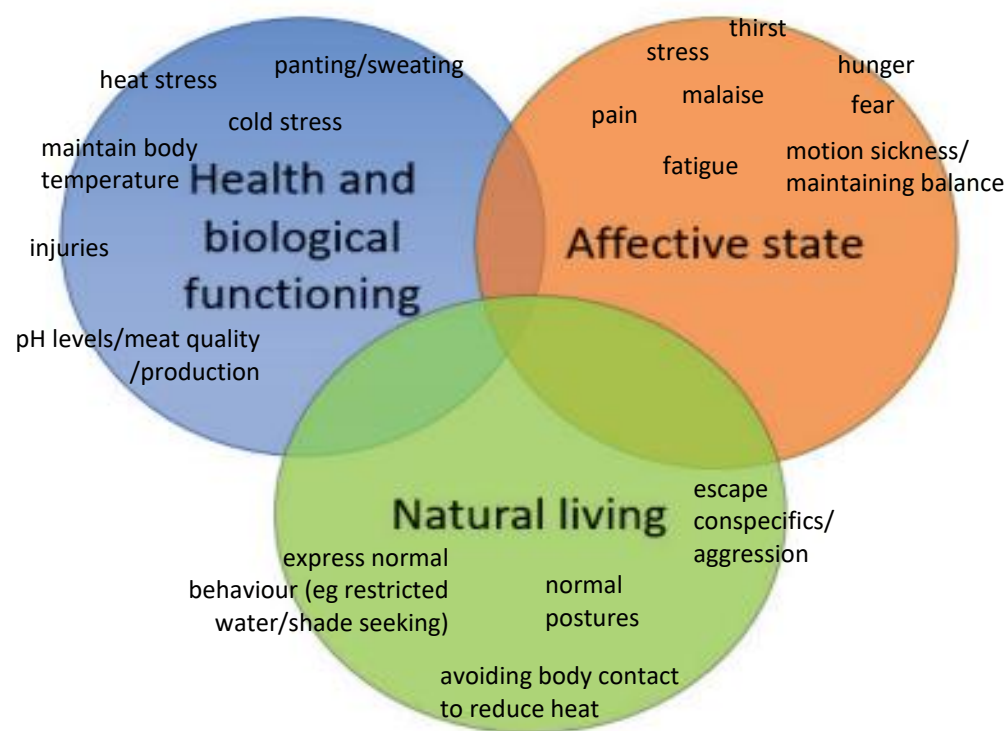


Figure 1. Factors animals can be exposed to and restrictions on normal adaptive behaviours during transport. Framework adapted from the original concept of Fraser et al. (1997).

All three categories overlap, but the pursuit of any one category does not guarantee a high level of welfare as judged by the others (Fraser, 2008). Historically, health and production and negative affective states, such as pain and distress, have been the focus when assessing welfare, but this has shifted to focusing on animals' positive and negative experiences.

Polsky and von Keyserlingk (2017) discussed how heat stress can compromise the affective state of dairy cows by inducing feelings of hunger and thirst. Other negative affective states that livestock may experience during transport include:

- fatigue/exertion due to long periods of standing and bracing the body to maintain balance;
- pain;
- fear;
- frustration when attempts to alleviate the stressful situation are hampered; and
- malaise due to the lack of rest, heat, motion stress or sickness.

The 2015 amendment to the Animal Welfare Act 1999 (the Act) incorporated a specific reference to the recognition that animals are sentient and therefore have the ability to perceive or feel things. This reflects the importance of taking into consideration positive as well as negative affective states and the ability for animals to perform behaviours that are important to them.

While research into affective state in animals has seen increased attention by animal welfare scientists and advocacy groups worldwide, there is a need for more science in this area. While it is not yet clear what the specific reference to animal sentience within the Act means for the livestock transport industry, NAWAC has previously indicated its intention to pay attention to positive and negative welfare states as future codes and standards are developed and reviewed, including the upcoming review of the transport code of welfare.

Factors impacting on animal welfare during transport

There are many features of transport that affect animal welfare including:

- bad handling during mustering, yarding, loading and unloading;
- inadequate preparation (e.g., mineral supplementation, time off pasture while providing hard feed and water);
- poor driving performance;
- poor road conditions;
- extreme weather conditions;
- insufficient ventilation;
- high stocking densities;
- mixing of unfamiliar animals in groups;
- animal age;
- inadequate water and food;
- vibration;
- vehicle motion;
- animals not being fit for transport;
- pregnancy status; and
- vehicle design, including insufficient deck heights.

The effects of these factors are influenced by the experience (e.g., previous exposure to humans/handling) and health status of the animals and the length of the journey. Animals that are young or old, emaciated, weak, sick or injured, or have not been previously exposed to handling, are less able to cope with the multitude of stresses imposed by the transport process than animals that are fit, healthy and in good condition.

These stressors can also impact on productivity and profitability through changes in animal body weight, hydration state and meat quality. Longer journeys have more potential to negatively impact animal welfare. Food and water deprivation become more pronounced, and fatigue is more likely on longer journeys.

In NZ, livestock journey lengths are not determined by the driver but are an outcome of economic and operational decisions, for example, to manage factors at slaughter premises such as staffing and processing of related stock classes. This means often animals are not transported to the nearest plant and may be transported longer distances that can include interisland ferry crossings across the Cook Strait. Ferry crossings introduce additional risks to livestock welfare associated with the lack of airflow during stationary periods, waiting at the wharf to load and during the journey, exposure to noxious gases and additional motion sickness.

Compared to sheep, beef and other livestock, vertical integration and specialisation means that pigs and deer are commonly transported by specialist transport operators and killed at venison or pork processing plants. Pigs are generally killed at the same weights with animals being transported weekly to slaughter plants, making the transport requirements more predictable and routine compared to other species. However, there are cases where pigs and deer are transported for long distances, including interisland crossings, due to meat companies' procurement processes and price incentives.

Other factors that influence journey lengths include the number of stops/pick-up points needed to make up a full load, availability of effluent and washing stations, waiting times at the meat processing plants, traffic hold ups and road conditions, and legal requirements around permitted driving hours.

The transport code of welfare does not set a time or distance limit for livestock transport journeys. However, it does require journey length to be taken into account alongside other factors to ensure animals can withstand the journey and arrive in the same condition in which they departed, avoiding pain, injury and distress. The exception is young calves where Regulation 34 sets a maximum journey time of 12 hours.

Heat stress in livestock

Livestock can be exposed to conditions that lead to heat stress that sometimes result in deaths during transport, especially during the heat of summer in NZ, with lambs being particularly susceptible. There is a large body of work focused on livestock heat stress and its management. Examples to refer to include Bracke et al. (2020), Galán et al. (2018), Kadzere et al. (2002), Polsky and von Keyserlingk (2017), Ross et al. (2015), Schütz (2022) and Silanikove (2000).

Livestock species are homeothermic animals, which means they can maintain a relatively constant body temperature despite wide fluctuations in environmental temperature. The range of temperatures when the animal needs no additional energy to maintain its body temperature is called the thermoneutral zone (Kadzere et al., 2002). Livestock species cope better at temperatures lower than the lower critical temperature (LCT) than they do with temperatures that are higher than the upper critical temperatures (UCT, Figure 2).

Livestock respond to increased heat load using a range of behavioural, biochemical and physiological processes to maintain normal body temperature (Silanikove, 1992). Cattle, sheep, goats and deer rely to a large extent on evaporation from the lungs, and to a lesser extent from the skin to lose excess heat. Pigs have a limited number of sweat glands, and therefore a limited capacity to lose heat by evaporation from the skin (Yousef, 1985).

The first sign that core body temperatures are under threat of heat load is an increase in respiratory rate, followed by panting. The risk and severity of heat stress is likely high when animals reach the upper critical level. Once this point is reached, the rate of evaporative heat loss starts to increase exponentially, meaning that signs of heat stress increase steeply in an effort to stop the rise in core body temperature above normal.

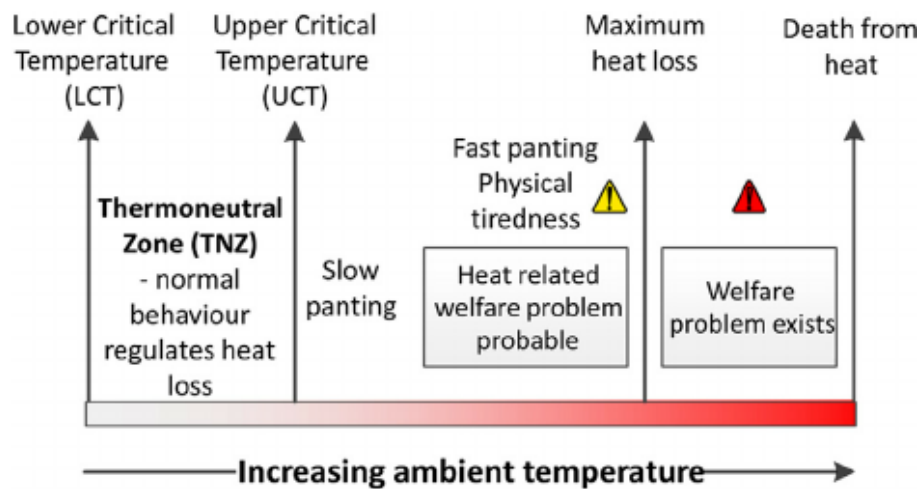


Figure 2. Representation of the thermoneutral zone, showing upper and lower critical temperatures, zones of metabolic regulation and the relationship between ambient temperature and heat stress in livestock.

Relative humidity is a critical factor contributing to the ability of animals to lose heat and the combined effects of high temperatures, humidity and air quality pose the greatest risks to welfare during transport.

The Temperature Humidity Index (THI, Figure 3) is considered a reliable indicator of heat stress in livestock (Silanikove 2000). A THI of less than 70 is considered comfortable, 75-78 stressful and above 78-80 causes extreme distress with animals unable to maintain normal body temperatures. THI does not account for solar radiation and wind speed, which are also important factors that influence the response to heat stress; therefore, the Heat Load Index (HLI) is now more often used, as it takes these factors into account (Sejian et al., 2018).

		Relative humidity (%)										
		0	10	20	30	40	50	60	70	80	90	100
Air temperature (°C)	20	18	18	19	19	19	19	19	19	20	20	20
	21	19	19	19	20	20	20	20	20	21	21	21
	22	20	20	20	20	21	21	21	21	22	22	22
	23	20	21	21	21	21	22	22	22	22	23	23
	24	21	21	22	22	22	23	23	23	23	24	24
	25	22	22	22	23	23	23	24	24	24	25	25
	26	22	23	23	23	24	24	25	25	25	26	26
	27	23	23	24	24	25	25	25	26	26	27	27
	28	24	24	25	25	25	26	26	27	27	28	28
	29	24	25	25	26	26	27	27	28	28	29	29
	30	25	26	26	27	27	28	28	29	29	30	30
	31	26	26	27	27	28	28	29	29	30	30	31
	32	27	27	28	28	29	29	30	30	31	31	32
	33	27	28	28	29	30	30	31	31	32	32	33
	34	28	29	29	30	30	31	32	32	33	33	34
	35	29	29	30	31	31	32	32	33	34	34	35

Figure 3. Graphic presenting THI levels indicative of moderate heat stress (yellow), severe heat stress (orange) and extreme severe heat stress (red) levels for livestock (Marai et al., 2007).

Risk factors for heat stress during transport

During transport, livestock are often exposed to factors that limit the effectiveness of thermoregulation and therefore increase the risk of heat stress, compared to non-transport situations. It is not uncommon for THI levels to reach those represented in the yellow, orange and red zones in Figure 3 within livestock crates during the NZ summer (Stewart et al. 2010).

Risk factors for heat stress during transport include:

- stationary periods (e.g., traffic hold ups, waiting to unload at processing plants and saleyards, parked on the wharf, ferry or roadside);
- insufficient head space for airflow;
- insufficient space between animals to allow evaporative cooling and avoid radiated heat;
- water deprivation;
- high stocking densities;
- lack of preparation for transport (e.g., loaded immediately after drafting without a stand-off period);
- inexperienced drivers;
- variable ventilation throughout the crate; and
- proximity to the vehicle's engine.

Bracke et al. (2022) discussed how the thermoneutral zone and comfort zones are impacted differently during transport due to factors and restrictions on normal adaptive behaviours to heat stress (shade seeking, avoiding body contact, changes in body posture, seeking water).

Requirements to prevent heat stress during transport

In the European Food Safety Authority (EFSA) Scientific Opinions (2022)⁶ it is recommended that the temperature inside vehicles should not exceed the UCT, which was estimated to be 25°C for cattle and pigs, and 32°C for shorn sheep (Figure 4). It also recommends minimum space allowances to enable animals to adjust their posture in response to acceleration and other events during transport.

NZ requirements are based on the welfare outcome of avoiding heat stress through the provision of appropriate ventilation, rather than prescribing the stocking density. Instead, the transport code of welfare places conditions on stocking density to avoid backrub and ensure a comfortable posture during transport.

The New Zealand Livestock Transport Assurance (NZLTA) Programme Manual, however, does provide loading density guidelines. These guidelines are outdated and were reproduced from the old *Code of Recommendations and Minimum Standards for Livestock Transported within New Zealand* issued by NAWAC (then AWAC) in 1994.

⁶ [More space, lower temperatures, shorter journeys: EFSA recommendations to improve animal welfare during transport | EFSA \(europa.eu\)](#)

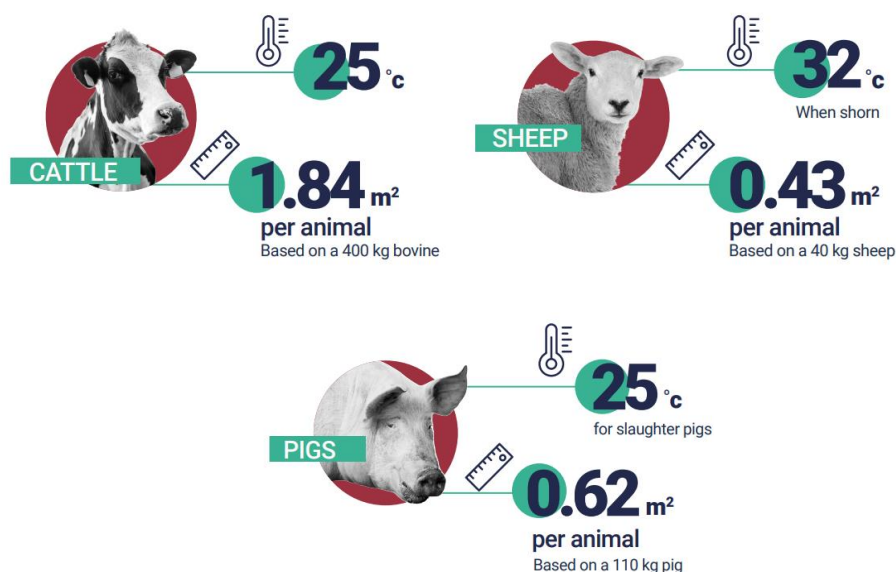


Figure 4. Upper critical temperatures (UCT) that should not be exceeded within the vehicle and space allowances, for cattle, pigs and sheep, recommended in the EFSA Scientific Opinion (2022). Note: these space allowances are recommended when microclimatic conditions are kept below the UCT.

Table 1 presents the industry space allowances for cattle against the larger space allowances required by the European Council and those recommended by Visser (2014). It should be noted that the NZ legal requirements take precedence over the industry guidelines, but the guidelines are used in the absence of a specific allowance being prescribed in the code.

Table 1. Minimum space allowances for cattle transported by road under NZ industry guidelines and European Commission (EC) requirements, compared to minimum space allowances required for an animal to move between lying and standing recommended in Visser (2014).

Category	Approximate weight (kg)	Regulation (EC) No. 1/2005 ⁷ minimum area (m ² /animal)	Minimum area (m ² /animal) to move up and down between lying and standing (Visser, 2014)	NZLTA Programme loading guidelines- minimum area (m ² /animal) by weight
Small calves	50	0.30 – 0.40	0.62	0.21 (50kg)
Medium sized calves	110	0.40 – 0.70	1.05	0.36 (100kg)
Heavy calves	200	0.70 – 0.95	1.55	0.62 (200kg)
Medium sized cattle	325	0.95 – 1.30	2.14	0.86 (300kg)
Heavy cattle	550	1.30 – 1.60	3.03	1.27 (500kg)
Very heavy cattle	>700	>1.60	3.55	1.5 (>600kg)

⁷ [EUR-Lex - 32005R0001 - EN - EUR-Lex \(europa.eu\)](https://eur-lex.europa.eu/lexuri-uri.do?uri=CELEX:32005R0001:EN)

NZLTA space allowances for sheep are half of those recommended by EFSA, with 0.21 m²/animal for a 40kg sheep with 25mm of wool vs. 0.43 m²/animal for a 40kg shorn sheep. These guidelines were originally based on a formula developed in the United Kingdom (UK) (Randall, 1993), where it was noted that space requirements were contingent on satisfactory ventilation and were only suitable for short journeys (less than 5 hours). As noted earlier, since then, there have also been several changes to legislation in NZ and public expectations around animal welfare, as well as changes to livestock crate designs (e.g., increased number of decks and reduced ventilation gaps) that pose risks of heat stress.

However, these guidelines and the transport code of welfare should be reviewed and updated to reflect current scientific knowledge, taking into account species differences, the various environmental conditions, journey length, and the ability for animals to thermoregulate, adopt a natural posture, and lie down if necessary.

Compliance and enforcement of requirements to prevent heat stress during transport

MPI VS veterinarians have been recording cases of thermal stress in animals arriving at meat processing plants since 2021. In 2021 and 2022, nine cases of heat stress were reported (MPI Report, June 2023). One case in pigs involved four deaths during transport and further deaths in the yards. Another case involved a cattle beast and seven cases, including three with a Cook Strait ferry crossing, involved a total of 388 sheep. There were 11 cases of cold stress, involving 341 animals (5 dead on arrival), which were all bobby calves arriving at meat processing plants wet and cold (MPI Report, June 2023).

While mortality rates are often viewed as low in proportion to the large number of livestock being transported, mortality rates during transport are likely to be under reported. Furthermore, death is not acceptable as a measure of animal welfare, nor is it an accurate assessment of the incidence of heat stress. This is because animals that are dead on arrival at a meat processing plant would have suffered prior to death, as would others on the same journey that survived the conditions.

It is also difficult to assess the number of animals that have suffered from heat stress during a journey without the ability to record THI, therefore heat stress cases are also under reported on arrival at meat processing plants. This is partly due to the cost and practicality of conducting the tissue sampling required for VS veterinarians to accurately diagnose heat stress as the cause of death.

In some countries, including in Europe, temperature and relative humidity are monitored within the vehicle and in some cases air conditioning units are used to mitigate heat stress once certain THI levels are reached.

Following the 2021 inquiry, the European Parliament considered it essential to develop more specific rules in the future on the optimal temperature ranges in transport vehicles. They considered such rules would need to take into account the different needs specific to species, age, physiological status, breed and ability to thermoregulate. It was recommended CCTV cameras and temperature/humidity and ammonia monitoring systems be fitted on

transport vehicles and national authorities should only approve animal travel plans if the temperature is forecast to be between 5°C and 30°C.

Installation of temperature/humidity loggers to measure THI inside livestock crates is the only practical way for MPI VS veterinarians in NZ to monitor compliance around requirements to prevent heat stress during transport and stationary periods.

This technology is available off the shelf and would help drivers to monitor conditions inside the crates, especially during stationary periods. The current challenge for drivers is what action to take if conditions start to reach UCTs, without any mechanical form of ventilation.

It is noted in the NZS 5413 standard (C4.3) that the shipping master of the vessel or shipping company (e.g., interisland ferries) may refuse to convey any livestock crate considered to have inadequate ventilation on fully enclosed decks unless suitable mechanical ventilation equipment is available.

To our knowledge there are no livestock crates in NZ fitted with mechanical ventilation and vehicles are still shipped on fully enclosed ferry decks during Cook Strait crossings. A NZ study showed the risk of heat stress was highest when vehicles were parked on the inside deck (Fisher et al., 2004).

NZ studies measuring environmental conditions within livestock crates during stationary periods and interisland ferry crossings

Dobbinson (2020) measured THI levels inside crates transporting pigs in a commercial truck and trailer unit and reported high THI levels (greater than 70) on 69% of the journeys on both the upper and lower decks. During stationary periods, THI levels increased and occasionally reached critical levels, with higher THI levels the longer the stationary period lasted. This effect was particularly pronounced if delays in unloading pigs occurred at the abattoir (Dobbinson 2020).

Research undertaken some 20 years ago investigated environmental conditions within livestock crates being transported on interisland ferries. Matthews et al. (2000) reported high levels of ammonia (above 100ppm/h) within pens of lambs and cattle during transport that included a Cook Strait ferry crossing. The author concluded that lambs were most at-risk, especially those transported on the lower decks and during the ferry crossing.

Fisher et al. (2002) compared environmental conditions when lambs were transported in what was a new crate design at the time in NZ, comprising a three-deck truck and four-deck trailer, or a more open older crate design, with a three-deck truck and three-deck trailer. The old and new design crates had a ventilation area of 13.9% and 8.1% of the floor area of the pens respectively.

Although thermal conditions during the study were not challenging (maximum ambient temperatures were 17-19°C), when vehicles were parked inside a shed to simulate the stationary period on an interisland ferry crossing, the THI was higher in the newer design (mean THI 76.1) than the older design (mean THI 73.6). By the end of the stationary period the older crate was 1.2°C cooler than the newer crate.

In a later study, Fisher et al. (2004) monitored the THI in two commercial vehicles transporting sheep, including an interisland ferry crossing, during a NZ summer. Figure 5 shows the crate configuration and the pens that were monitored.

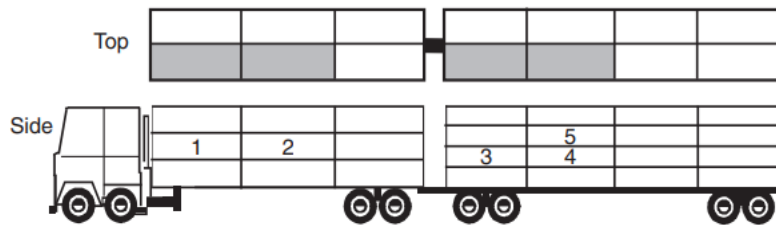


Figure 5. The crate configuration and location of the five pens monitored in Fisher et al. (2004).

The highest THI value (95) was recorded in the middle pen on the third deck of the trailer (Pen 5) parked on an enclosed deck of an interisland ferry. During all stationary periods, the THI was ≥ 75 for 34% and ≥ 80 for 21% of readings recorded in Pen 5. On average, the THI increased by 0.16 for every minute of a stationary period. Such conditions are known to predict significant thermal stress (Silanikove, 2000). Some increases in the THI occurred in stationary vehicles despite ambient conditions being mild, suggesting that lack of airflow was a critical factor, more so than ambient temperature.

Fisher et al. (2004) calculated that on a day of 27°C and 60% relative humidity, a stationary period of 65 min would result in a THI of 85 on average inside the vehicle. A study by Lowe et al. (2002) indicated at these THI levels, lamb body temperatures exhibit a steady and unremitting increase. In another NZ study, Stewart et al. (2010) reported increases in body temperature of sheep being transported, especially during loading and towards the end of a stationary period inside a shed simulating an interisland ferry crossing. Sheep body temperatures ranged from 39.0 to 40.0°C, with one sheep reaching 41.1°C, with a THI range of 80 to 100 while stationary.

Fisher et al. (2004) concluded that mild ambient conditions provided some protection against excessive THI increases if the duration of the stop was limited and recommended minimising the duration of stops where possible. It was also recommended that during warmer months, livestock vehicles should not be placed on enclosed ferry decks where airflow is minimal.

Unfortunately, in practice it is not always possible to keep livestock vehicles entirely out of enclosed ferry decks, and it is most often outside of the control of the driver or transport company. Despite efforts made by some ferry operators to prioritise parking livestock vehicles on outer decks, during our discussions with drivers and transport operators, they expressed concerns that this was not always possible especially when the ferry was full.

Even during milder temperatures, if vehicles are parked in a poor position, ventilation can be insufficient. For example, having vehicles that are transporting livestock or freight parked next to each other with a minimal gap between them will restrict airflow.

It was difficult to verify what procedures were in place for both interisland ferry companies, as only one company responded to our requests for data. For the one-year period prior to 1 October 2023, this company transported 3,213 livestock vehicle units (including commercial horse trucks) and had included guidelines for transporting livestock in a standard operating procedure.

Therefore, it appears that improvements are still needed to ensure livestock are not exposed to the unnecessary risk of heat stress on interisland ferries, especially during the summer months.

Proposed next steps:

- To help monitor conditions inside the crates, data loggers could be installed in livestock crates to measure THI so that, where possible, preventative action can be taken to mitigate thermal stress during transport and stationary periods.
- Research is needed to determine optimal stocking densities to provide more relevant and useful guidelines regarding the impact on ventilation, air flow and air quality than the current density limits, which were developed using mathematical equations based on animal weight and height.
- Ferry companies should work with transport operators, meat companies and other relevant parties to develop an interisland livestock transport policy. This would ensure livestock are not exposed to any unnecessary risk of heat stress and vehicles are appropriately managed and positioned on the wharf and the ferry. This could include heat stress mitigation strategies and contingency plans.

5. General design features of livestock crates in NZ and some overseas comparisons

Although NZ livestock crate manufacturers generally build to a standard design, they are legally restricted by the NZS 5413 standard and the road regulations (i.e., weight, length and height). Different transport companies have certain design preferences in respect to appearance, ease of cleaning and durability, therefore certain features and construction are generally dictated by these preferences.

During discussions with crate manufacturers, they all considered that anything the client requested could be built and although there would be some trade-offs regarding weight and structural requirements, most things could be implemented. All the manufacturers and transport operators we engaged with considered the NZS 5413 standard to be so outdated that the crate designs have long since superseded the standards.

NZ livestock crates are unique compared to overseas crates, with multiple deck configurations and deck heights designed to accommodate multiple species of different ages.

Crates range in size and configuration as follows:

- single-deck cattle, single-deck sheep;
- single-deck cattle, two-deck sheep;
- single-deck cattle, three-deck sheep;
- two-deck cattle, two-deck sheep or three-deck sheep; and
- two-deck cattle, four-deck sheep.

When animals are loaded onto the bottom deck, the floor of the pen above is lowered into place to act as a ceiling. The floors are designed to be watertight to prevent rainwater and faeces and urine from the animals on upper decks soiling those on the decks below.

Although this is a necessary feature, it also means any air flow from the top deck to the lower decks is severely restricted.

The top deck in most NZ livestock crates does not have a roof, but use of covers is recommended to prevent animals jumping out and to provide some shade. In the Northern Hemisphere, the majority of vehicles have a solid roof over the top deck to provide protection from cold, rain and snow. However, this would reduce the airflow within the top deck of the crate and larger ventilation gaps or mechanical means of ventilation would be required.

The heights of each pen within the crates varies depending on the configuration and is primarily determined by the deck height of the truck or trailer unit. This 'one size fits all' crate design poses challenges for the industry to meet some of the current animal welfare standards around sufficient head space and ventilation for some livestock (see a more detailed discussion in the sections below).

Standard livestock trucks have a rigid trailer unit that is towed behind the truck, making it more manoeuvrable for the windy, narrow roads and farm entrance ways/tracks often encountered in NZ. Whereas, in Canada, USA and Europe, articulated vehicles are more common. Some of these designs provide better protection for animals from more extreme heat and cold compared to NZ livestock crates.

Most new livestock crates in NZ are built with oval ventilation gaps running along the side of the crates (Figure 6). The fibreglass crates, which are less popular now, had round holes and most of the older aluminium crate designs had an opening running the full length of the crate (Figure 7). The NZLTA Programme recommends a continuous opening on the external walls or roof of each pen, however, very few new livestock crates are built with ventilation gaps that run across the full length of the side of the crate.



Figure 6. Oval ventilation holes running along the side of a newly built livestock crate (left). Note that the floor folded against the wall is blocking the ventilation gap in both photos.



Figure 7. Ventilation gaps in older NZ livestock crates with continuous openings along the sides of the crate.

Design features incorporated overseas for temperature regulation include air conditioning units or fans for cooling, solid roofs covering the top deck and larger ventilation gaps/wall openings to provide airflow (Figure 8). These can be covered up during the winter using removeable boards or flaps on the outside walls (Figure 9) to prevent cold stress. Some newer designs have incorporated pneumatic/hydraulic remote operated flaps. Sometimes panels are used on the internal walls for extra insulation to reduce heat loss in winter.



Figure 8. Example of livestock crates in UK showing a greater amount of ventilation compared to NZ livestock crates.



Figure 9. Some overseas livestock crates with flaps that can be opened in hot conditions to increase airflow and closed over the ventilation gaps to reduce heat loss in colder conditions.

Another consideration is the crate construction material, which needs to be lightweight while being robust enough to withstand the stresses of road transport. Different materials have different thermal conductivity that can impact on the temperature inside the crate. For example, Matthews et al. (1994) found the maximum temperature inside alloy crates carrying deer was higher than in those made from steel.

The majority of crate walls in NZ are made of aluminium. For a period, fibreglass was popular due to its lighter weight compared to aluminium. However, due to the lack of durability of the fibreglass material, very few are built and less are used on NZ roads now. A potential disadvantage of aluminium is that it is a good conductor of heat. Fibreglass has the advantage of providing better insulation than aluminium but tends to tear at points where flexing or movement is high (Dobbinson, 2020).

Another factor that most transport operators don't take into consideration is the colour of the crates. Darker colours absorb more light from the environment, therefore more heat. Although no studies have been undertaken to assess the impact of crate colour, darker coloured crates are likely to create higher internal temperatures. The colours of livestock crates in NZ are typically dictated by company branding and image.

In some countries such as USA and Canada, it is common practice to use bedding (e.g., woodchips, sawdust or straw), especially for young animals during colder months. During discussions with transport operators, it was considered the use of bedding in NZ crates would be impractical due to the issues managing effluent, biosecurity issues and disposal of used materials.

Another common feature of overseas crates is the wider internal loading ramp and door opening (Figure 10), which helps provide unobstructed entry and may reduce injuries. In some countries, hydraulic ramps to reduce the need for animals to climb steep ramps are also used.



Figure 10. Wider ramps and door openings in some overseas designs.

In some countries, such as in North America and Australia, animals are generally loaded and unloaded from the side of the vehicle rather than at the rear. Pot-bellied vehicles (punch-hole trailers) are common in Canada and USA for transporting pigs and have a greater amount of ventilation openings compared to NZ crates (Figure 11). They are often dual-purpose (transporting either pigs or cattle) and allow the transportation of large loads of pigs (more than 200) on three decks (10 compartments) in one journey.

A large number of studies in the pig transport literature have used pot-bellied vehicles (e.g., Sutherland et al., 2009; Weschenfelder et al., 2013), which are difficult to compare to NZ conditions. However, studies have shown that pot-bellied vehicles cause more stress during loading and unloading compared to flat-deck vehicles (Weschenfelder et al., 2013), largely due to steep internal ramps (i.e., 40 degree slope to reach belly compartments).



Figure 11. Pot-bellied vehicles, typically used for pig transport in USA, showing the greater amount of ventilation compared to NZ livestock crates.

Care should be taken when comparing NZ livestock crate designs to overseas designs, due to the differences in road conditions (i.e., often narrow, windy), road height and weight restrictions, climate differences, outdoor (grass fed) vs. indoor management systems and breed differences (e.g., size). However, given the variable nature of our climate, seasonal patterns and concerns about weather extremes increasing the risk of heat stress, some design features of overseas crates should be considered.

Key drivers for change to livestock crates in recent years

Over recent years, the main drivers for changing the design of livestock crates have been due to pressure on the industry to address concerns from councils and road users regarding effluent spillage from trucks, meet other regulatory requirements (e.g., back rub), improve

image and reduce transport costs, with less consideration about what design features would help to improve animal welfare.

Key drivers for changes to crate design changes include:

- improve effluent management (drainage/storage, ease of cleaning);
- reduce transport costs;
- increased loading capacity (e.g., change from one- and two-decks, to three- and four-deck crates);
- multi-purpose/species (e.g., fold away floors);
- improve driver health and safety;
- preferences around appearance of the crates and company image (i.e., the unit presents a good image when seen on the road); and
- compliance with back rub regulations (2018) (e.g., drop down floors to increase deck heights).

Over the years, this has resulted in a fleet of species-specific livestock crates being replaced by multi-purpose crates to accommodate different species, with the exception of deer, where the majority are still transported in purpose-built crates.

Multi-purpose crate designs incorporate effluent drains and storage systems, and flooring systems designed around ease of cleaning and the ability to fold floors away for configuration of different deck heights. This 'one size fits all' approach poses risks to animal welfare, as many of the design features do not take into account the different sizes of livestock, species-specific responses to stress, thermoregulatory abilities and behavioural needs of the different types of livestock.

In addition to the change to three and four-deck crates, other factors have led to insufficient space within the crate pens and back rub issues, such as the implementation of walking platforms for drivers on the top deck to address health and safety concerns of working at height, and selection for increased growth rates, resulting in larger animals.

6. A closer look at key areas of crate design

The following sections of this report will consider key areas of crate design (i.e., ventilation, space, covers/shelter, floors and ramps) that fall under the requirements set out in the transport code of welfare and regulations, and the industry standards; being the NZLTA Programme, the NZS 5413 standard, the Stock Crate Code and the DeerQA - Transport Quality Assurance Programme.

Relevant NZ standards are presented at the start of each section and international standards and guidelines are discussed under each topic area.

6.1 Ventilation

Code of Welfare - Minimum Standard No 8 – Ventilation

- a) Ventilation or oxygenation must be sufficient to **prevent the build-up of noxious gases** or impurities to an extent that causes pain or harm to the animals' health during travel and rest.
- b) Ventilation during travel and rest must be appropriate to maintain the body temperature within the normal range for the species.
- c) Where animals show signs of heat or cold stress or distress from exposure to noxious gases, immediate **corrective action must be taken**.

Code of Welfare - Minimum Standard No 2 – Design

Conveyances and containers must be designed:

- to **ensure enough room to enable animals to travel in a natural posture**.
- to **ensure adequate ventilation** or oxygenation to **allow the free flow of air** or oxygen to all animals, **even when stationary**, to prevent the build-up of harmful concentrations of gases or impurities, water vapour or temperature.
- to provide protection from adverse weather that may be a risk to the animal's health and welfare.

NZS 5413 standard 4.4.1-4.4.2

Ventilation gaps shall be as high as is practicable for any deck. Note: Some form of shuttering may be required in some areas in winter because of the chilling effect of the vehicle's movement.

All stock crates shall have openings placed to ensure the adequate circulation of air through the crate. Note: Fully enclosed stock crates or vehicles must have adequate ventilation when stationary.

Stock Crate Code 4.4.1

The horizontal or vertical **ventilation gaps shall not be greater than 100mm** (this is to prevent an animal's leg coming through the side of the crate). If the gap is wider than the dimensions described the aperture opening can be reduced by fixing a rod through the middle

Ventilation shall be sufficient to **provide adequate airflow to all pens** when fully loaded to **prevent overheating or suffocation** of stock.

NZLTA 2.2.4

- It is preferable that there be a continuous opening on the external walls or roof of each pen.

DeerQA Transport Programme

For each pen there must be a continuous opening on the external walls or roof at the top of each pen to allow unrestricted movement of unpolluted air. Total width of openings must be not less than 100mm for each deck; where ventilation is not continuous the areas of opening must be equivalent.

Airflow within livestock crates

Adequate ventilation is essential to provide for animals' thermoregulatory needs and to remove ammonia, carbon dioxide, humidity and excess heat. This is a requirement in the transport code of welfare and across the industry standards. However, standards regarding ventilation are generalised and ambiguous, with no specific design requirements.

There are two mechanisms to provide air flow within a livestock crate. Thermally induced ventilation caused by air temperature differences on either side of the aperture and forced ventilation caused by vehicle motion, wind or mechanical ventilation such as air conditioning or fans (Randall and Patel, 1994). Vehicle motion creates airflow from pressure differences between the inside and outside of the vehicle when the truck is moving.

Increasing the air movement within the crate removes both heat and moisture generated by the animals from respiration, surface evaporation and excreta, providing animals with a relatively drier micro-environment than would otherwise occur in conditions of minimal air movement (Kettlewell et al., 2001).

NZ livestock crates do not have artificially controlled ventilation and therefore rely on passive airflow through the crate. Passive airflow is generated by the movement of the truck which pushes into a force field, generating turbulence along the sides of the truck and airflow in from the back. The net effect of the pressure field around a moving vehicle is that air enters at the rear, moves forward within the crate and leaves through the front (Figure 12).

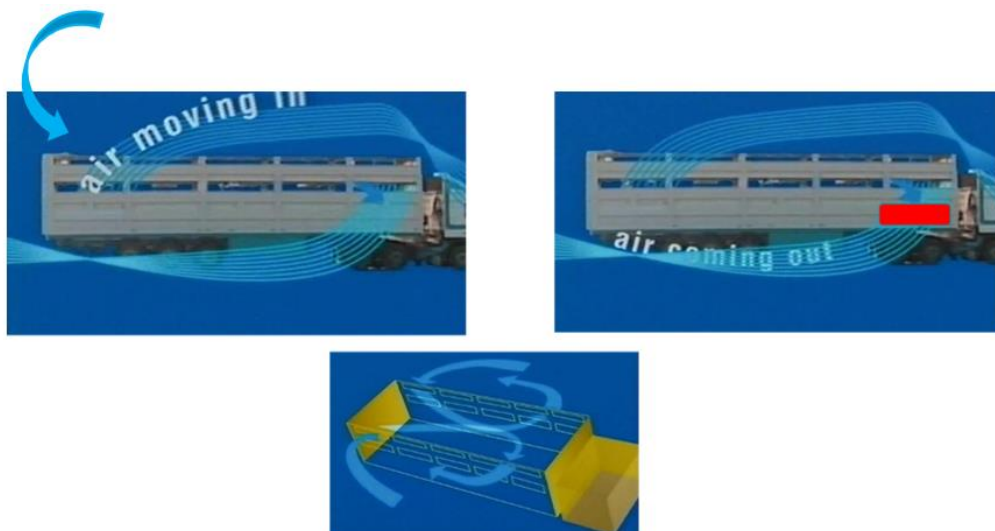


Figure 12. Airflow direction in a passively ventilated livestock crate. The red box indicates the pen that is usually the hottest.

Studies using wind tunnels and computational fluid dynamics demonstrated that air flow in upper and lower decks differ significantly (Gilkeson et al., 2009; Norton et al., 2013). These studies demonstrated that ventilation rates are much larger with air residence times much smaller on the upper deck, and ventilation improves as vehicle speed increases. Watts (1982) considered that when there is no forced ventilation in vehicles, a 4-6°C temperature

differential is required to create an adequate airflow, provided there are relatively large ventilation openings on each side of the crate.

Internal partitions and a lack of head space between the top of the animal and the ceiling of the pen can restrict air flow coming forward to all pens. Therefore, the hottest pens are usually at the front, behind the driver's cab, where heat from the engine adds to the heat generated by the animals (Gilkeson et al., 2009). In a NZ study, Dobbinson (2020) reported that the majority of pig mortalities occurred in the bottom front pens of the truck and trailer units, with higher numbers in the truck crate compared to the trailer.

This finding led Dobbinson to investigate the use of an insulation material on the front wall of the crate to help reduce the heat being conducted through the aluminium wall. Unfortunately, due to a large amount of variability in temperatures and humidity recorded inside the pens, no differences before and after installing the insulation were found. However, it was considered further research was needed to test different materials to determine if this approach might help improve conditions in the front pens of NZ crates.

The internal partitions are currently designed to meet the industry standards (NS 5413, Stock Crate Code, 4.4.5), which require partitions to be solid to a sufficient height to prevent contamination between pens and states that this is not necessary for sheep. These standards are ambiguous and focus on contamination between pens rather than providing optimal airflow and taking into account species differences and driver safety. In addition, it is not clear what type of contamination it is proposed to prevent, although it is presumably faecal contamination.

Passive airflow can be increased by increasing the size of the ventilation slots and/or increasing the pen height and lowering stocking density, since high stocking densities also obstruct natural airflow. When mechanical ventilation is not available, and particularly to maintain appropriate conditions within a stationary vehicle, fewer animals or larger ventilation slots may be required.

Ventilation holes drilled through the front wall of the crate have been considered as a way of increasing airflow into the front pens (Mitchell and Kettlewell, 2008). Some 'air scoop' designs have been experimented with in NZ, for example in the older fibreglass crates. This system was considered an option to increase airflow during our stakeholder workshops. However, there were some concerns around animals being exposed to cold, since it wasn't possible to close the vents off during colder conditions, and rain entering the crate. It still seems possible these issues could be overcome by further development of these types of systems.

There is a gap in the literature regarding prevention of cold stress, especially in young animals that are more vulnerable to cold stress in winter (e.g., bobby calves). Although covers are required on the top deck, these are not usually waterproof and ventilation gaps also create an opening for rain to enter through. In some overseas designs, this is overcome by installing flaps over the ventilation openings, some of which are operated remotely. It is noted in the NZS 5413 standard that some form of shuttering may be required in some

areas in winter because of the chilling effect of the vehicle's movement. However, to our knowledge, no NZ crates have incorporated this design feature.

Fans or air conditioning systems are used to provide air movement within some livestock transport vehicles overseas. When active ventilation is used, extracting air from the crate is preferable to blowing air in, and needs to be positioned to ensure airflow is passed over all animals during transport irrespective of vehicle movement (Kettlewell et al., 2001; Mitchell and Kettlewell, 2008; Norton et al., 2013). The Council Regulation (EC) No. 1/2005 stipulates that vehicles for long journeys should have a ventilation system which is capable of maintaining the temperature throughout the journey to between 5°C to 30°C.

In the study by Dobbinson (2020), fans did not make any significant impact on temperature and humidity within crate pens transporting pigs. It was suggested that if the wall openings were larger, it may have allowed more air to be moved in and out of the pens. It was concluded that further research was needed to determine if a positive pressure ventilation system could be used to improve conditions in NZ livestock crates and reduce heat stress, especially during prolonged stationary periods.

However, as discussed by Dobbinson (2020), there are also practical considerations that need to be taken into account. For example, due to the limited space and low ceilings inside the pens, any mechanical ventilation equipment, such as a fan, would likely cause injuries and be interfered with by the animals. The European Commission recommends the ventilation capacity of mechanical systems should be at least 60m³/h/100kg of live weight for short and long journeys.

Most of these systems used overseas are installed in single deck vehicles with walls completely closed off. Therefore, investigation into and/or development of new technologies would be required to assess if any systems would suit NZ conditions and crate designs to provide adequate ventilation (i.e., optimal wall opening for a moving vehicle vs. stationary periods).

Ventilation gaps/openings within livestock crates

The size as well as the position of the ventilation gaps are important design considerations. Randall and Patel (1994) considered ventilation openings as the most important factor influencing temperature within livestock vehicles, more so than stocking density or vehicle construction. They calculated that stocking density needs to be reduced substantially (25 to 30%) to affect internal air temperature during stationary periods, and a reduction of 30% in stocking density for lambs would result in a reduction of only 1°C in vehicle temperature.

However, Fisher et al. (2002) found THI was lower when stocking density was decreased to be 20% lower than that used in standard practice in NZ at the time. Dangerously high THI values above 80 were recorded during a stationary period simulating a ferry crossing and THI was above 90 for lambs transported at the standard stocking density (0.20 m² per 35 kg lamb compared to 20% lower density, 0.26 m² per 35 kg lamb).

Dobbinson (2020) suggested that the pens in NZ livestock crates were inadequately ventilated for transporting pigs. It was considered with the increasing size of livestock over

recent years, ventilation allowances might have been appropriate at the time of the original livestock crate designs but are more likely to now be ineffective for managing heat stress in livestock being transported in NZ, and further studies investigating the impact of varying wall opening dimensions was needed.

From discussions with transport operators, the preference for oval ventilation gaps appears to be around the appearance of the vehicle and company image, and some thought a continuous gap would cause structural issues. However, feedback from crate manufacturers confirmed it is not to do with structural aspects of the crate and some transporters still request full length ventilation gaps for new builds.

Randall and Patel (1994) recommended that vents should run the full length of the vehicle and a reduction in up to 5% in length due to structural members crossing it has a negligible effect on internal temperature. The European Commission guidelines recommend the ventilation surface should be $\geq 40\%$ of the total area of the container sides for passively ventilated vehicles.

There are no science-based guidelines for the optimal ventilation gap for NZ crates. No dimensions for the ventilation gap are specified in the NZ 5413 standards, but the Stock Crate Code restricts the opening to being no greater than 100mm wide. This standard appears to focus on the need to prevent an animal's leg from protruding through the gap rather than providing airflow. If the gap is wider than 100mm, the aperture can be reduced by fixing a rod through the middle. Crate manufacturers in NZ reported there are some transport operators who request new crates to be built with a wider ventilation gap to increase airflow, with the rod incorporated to meet the standards.

Randall and Patel (1994) calculated that a reduction in vent area from 20% to 10% of the floor area would result in an increase of 5°C within the vehicle. They recommended that ventilation openings should be a minimum of 20% of the floor area along the total length of both sides of the vehicle.

Fisher et al. (2002) found that THI was higher in a newer design crate (average THI, 76.1) compared to an older design (average THI, 73.6). The old and new crate had a vent area of 13.9% and 8.1% of the floor area of the pens respectively. Although maximum ambient temperatures were only 17-19°C, when the vehicles were parked inside a shed to simulate a stationary period on an interisland ferry crossing, the older crate was 1.2°C cooler than the newer crate by the end of the stationary period.

It is not uncommon in NZ to see ventilation gaps blocked by the animals themselves, especially when sheep are tightly loaded. Also, floors in livestock crates are designed with the flexibility to be folded against the wall to accommodate different configurations for different species. Therefore, it is also not uncommon to see folded floors, or centre dividing gates not in use, blocking the ventilation gaps (Refer to Figure 6).

Crate manufacturers have designed a floor that folds in a way that does not block the ventilation gap and some transport companies have adopted this design. The floors on the second and third decks operate in a 'concertina' type action and fold in such a way that they

don't block the ventilation gaps when the floor is folded up. While some transport companies have adopted this design, others considered it reduces too much space within the pen (by 50mm).

The height dimensions of the animal must be taken into consideration when designing the shape and positioning of ventilation gaps to ensure they are open and free of any obstructions at head height. If the ventilation gap was positioned at the appropriate height within each pen, there would be minimal risk of legs protruding through the gaps. However, because NZ crates are designed to enable different deck configurations to accommodate different species, the ventilation gap is not always positioned at head height.

Management of effluent impacts the design of ventilation openings in NZ livestock crates

The width of the ventilation gap is restricted by the need to contain effluent and minimise effluent escaping onto the road. The NZS 5413 standard outlines requirements for drainage and control of effluent spillage. The Industry Code of Practice for the Minimisation of Stock Effluent Spillage from Trucks on Roads (2003)⁸ was also developed to minimise effluent spillage on roads and address public and environmental concerns, road safety and industry reputation.

It may be possible to overcome the concerns about widening the ventilation gap by developing a design or construction material that allows a larger gap for airflow while still satisfactorily containing all parts of the animal and effluent. Species-specific crate designs would be an alternative option where the gap could be positioned at the appropriate height to prevent effluent escaping and limbs protruding.

Farmer education around appropriate stand-off procedures would also go some way to resolving the issues transport operators have managing effluent. During discussions with transport operators, they expressed frustration that many farmers do not stand animals off pasture as required.

In a farmer survey, 303/468 (65%) of farmers reported that they stood sheep off pasture for 3-12 hours before transport, with the remainder for shorter (21%, 96/468) or longer (14%, 64/468) periods (Fisher et al., 2012). Often insufficient communication between stock agents and farmers leads to livestock not being prepared properly for transport. Therefore, more farmer and livestock agent education is required to highlight the importance of best practices for standing livestock off pasture prior to transport.

Guidelines include information on standing livestock off feed prior to transport (4-8 hr), collection, containment (onboard effluent holding tanks) and disposal of effluent from trucks. The appropriate time for standing livestock off is dependent on the condition and health status of the animal and the type of feed provided before transport. The provision of

⁸ Industry Code of Practice for the Minimisation of Stock Effluent Spillage from Trucks on Roads. (2003). National Stock Effluent Working Group.

dry food is recommended during stand-off when on long journeys. This is important especially on longer journeys where feed deprivation and hunger are likely.

Fisher et al. (2015) reported that sheep adapted to different periods of feed deprivation by mobilising their energy reserves without any evidence of metabolic depletion, however, they concluded that they likely experienced a degree of hunger.

Many transport operators considered that livestock load, travel and unload better when stood off for an appropriate time. This was also the view of many farmers interviewed in the survey by Fisher et al. (2012). Effluent also contributes to slippery surfaces and difficulties in animals standing during transport (Ferguson, 2006). This is also a risk for driver safety, increasing the risk of falls and slips.

Some transport operators had also observed an increased risk of heat stress when animals are loaded straight after mustering and yarding without any stand-off period. Indeed, Sutherland et al. (2016) showed that high intensity handling and exercise prior to transport for slaughter of lambs resulted in behavioural and physiological indications of stress, including panting, and changes in meat quality characteristics.

The welfare impacts of time off feed prior to transport and slaughter remains a gap in scientific knowledge for most species and classes of livestock, and more research is required under NZ conditions. If livestock could be transported after relatively short periods off pasture this could reduce the period of time they are deprived of food prior to slaughter (Fisher et al., 2012).

The lack of disposal facilities for effluent was also raised as an issue by transport operators and this needs to be addressed.

The design of livestock crates prevents sufficient monitoring of livestock during transport

The NZLTA programme requires regular inspections of animals during transport and recommends every 2 hours to be appropriate intervals for checking on livestock. The transport code Minimum Standard 9 requires that *animals must be inspected for injury or signs of pain or distress at regular intervals during the journey, including at rest breaks taken by the driver and at refuelling stops. Animals found to have fallen down, to be injured, distressed or with a limb protruding from the container or conveyance must be assisted, treated or euthanased as soon as practicable.*

The current design of ventilation gaps in NZ livestock crates makes it difficult for drivers to view animals properly and meet these standards, especially when stocking density is high and not all crates have sufficient lighting to allow livestock to be inspected at nighttime. Also, many drivers are not experienced enough or trained to assess welfare and indications of heat or cold stress.

Furthermore, due to the nature of the job (e.g., long hours, pressure to meet tight schedules dictated by stock agents and meat processors and legal driving hours) it is unlikely these standards are being met. As a result, welfare issues are usually only revealed when animals are unloaded.

Proposed next steps:

- The following scientific research is needed, based on an understanding of the different needs of each species:
 - determine optimal positioning and dimensions of wall openings to ensure sufficient airflow and quality within crates and develop designs/construction materials that allow larger openings while containing effluent.
 - develop new technologies to help maintain appropriate environmental conditions within all pens and deck levels during transit and stationary periods.
 - investigate the risk of cold stress in different species being transported across different regions.
 - develop designs or systems to prevent rain and cold entering crates to prevent cold stress, which could include covers/shutters that provide both sufficient shelter and ventilation.
- Farmer education programmes should be developed to improve awareness and compliance with the requirements for appropriate preparation of livestock prior to transport, including information regarding time off pasture.

6.2 Head space requirements

Code of Welfare – Minimum Standard No 7 – Loading/Unloading

j) Stocking density must be sufficient to **allow animals to adopt a natural posture** during the journey **without injuring their heads or backs if they stand**, and to allow animals to rest, if this is necessary during the journey.

Code of Welfare – Minimum Standard No 2 – Conveyance and Container Design and Maintenance

d) Containers must be designed to ensure enough room to enable animals to travel in a natural posture.

MPI Regulation 32 Prevention of back-rub

A person must not transport a cattle beast, deer, sheep, goat, or pig in a manner that causes back-rub.

NZS 5413 standard 4.4.6 and 4.6.3

Crates without a roof shall have side walls fitted with a return at the top and be high enough to discourage animals from escaping. Note: Animals **shoulders shall not exceed the maximum height of the crate side** or end walls, and (horses only) crate allows for adequate head height for the animal when standing normally.

Crates used specifically for the cartage of bobby calves should have a **minimum height of 950mm** between decks. Note: When the upper deck is raised effluent shall not fall onto lower decks.

Stock Crate Code 4.4.6

For unconditional carriage of adult cattle **on the top cattle deck the height must be at least 1400mm**. If the deck height is less than this there will be a condition such as – “No cattle with a shoulder height greater than 1350mm (or whatever the deck height is) to be carried on the top cattle deck”.

For **young calves** to be carried on the top deck the **height must be at least 900mm**.

NZLTA 2.2.1

Stock must be able to **display a normal pattern of behavior and posture**.

The height of the deck must allow sufficient room for all livestock to have **freedom of head movement and be able to stand without being in contact with the roof** above them so they do not injure their head or back.

DeerQA Transport Programme

Deer within the crate must be able to display a normal pattern of behaviour.

The box above outlines the requirements for head space or deck height in NZ. One of the issues with these standards is that they are too generalised and ambiguous, and it is not clear what constitutes a natural or normal posture/behaviour or head position. Many transport operators considered these outcome-based standards difficult to interpret and requested more clarity to ensure they could meet the standards.

The only standards that specify a required deck height in NZ is the requirement for transporting bobby calves in the NZS 5413 standard (4.6.3), which specifies a minimum height of 950mm between decks. However, the Stock Crate Code specifies the top deck

height for calves must be at least 900mm. The Stock Crate Code also builds on the NZS 5413 standard (4.4.6), requiring a top deck height of 1400mm for cattle. If the deck height is less than 1400mm, a condition is required *‘such as’ no cattle with a shoulder height greater than 1350mm (or whatever the deck height is) to be carried on the top cattle deck*. The DeerQA Programme standards also recommend single deck trucks only for transporting large wapiti or elk.

Regulations in Canada⁹ are similar to NZ and require animals *to be able to stand at all times within the conveyance or container with all feet on the floor, with head elevated, with sufficient space to permit a full range of head movement and without any part of its body coming into contact with a deck, roof or top of the conveyance or cover of the container*.

Providing animals with the ability to stand up, turn around, groom themselves and stretch their limbs, has long been considered a basic requirement for good animal welfare (e.g., the Brambell Committee Report, 1965). Additionally, sufficient space above the animal’s head is required to increase air flow to reduce temperature and humidity in hot weather, reduce noxious gases, reduce unrestricted movement and injuries and allow animals to stand in a normal posture and/or their preferred orientation for balance (Figure 13).

In general, space allowances (i.e., head space, stocking density, crate capacity) during transport must take into account ambient temperature, relative humidity, amount of ventilation or air flow (natural vs. artificial), the likelihood of prolonged stationary periods, different thermoregulatory abilities for the species being transported and the need to lie down.

Without sufficient head space to allow animals to stand in a normal posture, animals may be forced to lie down during transit. They are also restricted from displaying normal behaviour and having freedom of head movement, have a higher risk of injuries and/or back rub and are less likely to be able to stand without being in contact with the ceiling (Figure 14). Therefore, without sufficient head space within NZ crates, it is not possible to meet the transport code of welfare and regulations or the current industry standards.



Figure 13. Heifers with their heads raised above the height of the withers during transport in a two-deck truck in Denmark, allowing them to stand in a normal standing posture without being in contact with the ceiling of the pen.

⁹ [Canada Gazette, Part 2, Volume 153, Number 4: Regulations Amending the Health of Animals Regulations](#)



Figure 14. The back of a cattle beast touching the ceiling before the floors were folded down in a NZ livestock crate.

These standards need to be reviewed to clarify the measurement points of the animal, for example, the highest point of the back or the head and the head room required between the head and the cover/ceiling.

Back rub regulations in NZ

Back rub is an animal welfare issue as it results in painful skin lesions and severe bruising, but it has the potential to be mitigated through improved livestock crate design. Changes in NZ crate designs over the years that have reduced the volume of the crate per animal and head space, as well as genetic selection for growth, have contributed to incidences of back rub being exacerbated. In 2018, new rules were incorporated into the Animal Welfare (Care and Procedures) Regulations, making it an offence to transport livestock in a manner that causes injury and back rub.

Back rub also has implications for meat quality with associated costs to the industry, as well as resource costs for MPI to enforce compliance, and the cost of infringements to transport companies. Since the regulations have been enforced by MPI, transport companies and crate manufacturers have focused on optimising crate designs to reduce the risk of back rub during transport, with some innovative solutions implemented. For example, step down floors in an attempt to optimise the deck heights within the pens, excluding as many protrusions within the crates as possible and ensuring wall and ceiling surfaces are as smooth as possible.

In 2022, back rub offences made up the majority of transport infringements issued (133) to transport companies by MPI. However, overall, since back rub regulations have been enforced, the number of infringements has declined. This is likely due to some of the crate design improvements, but also reflects the increase in awareness and education across the industry, and motivation to avoid infringements. During discussions with transport operators, many considered that further farmer and stock agent education is required, as often animals are not drafted into appropriate groups by height for loading before transport.

Figure 15 shows the increase in the average carcass weight of pigs in NZ from 1996-2018 and Figure 16 shows a steady increase in average carcass weights for sheep and cattle being exported from NZ.

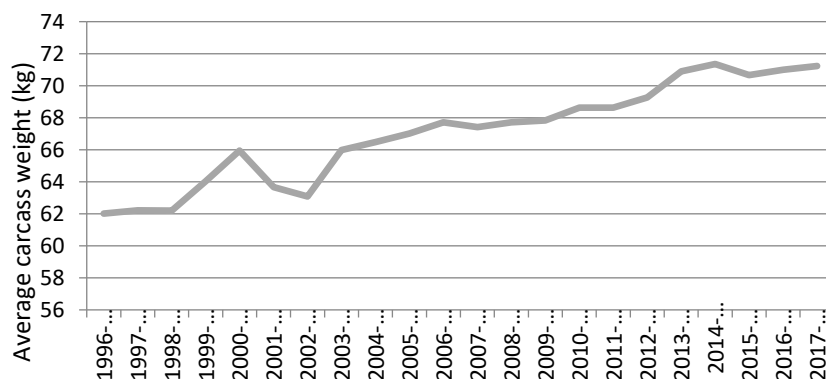
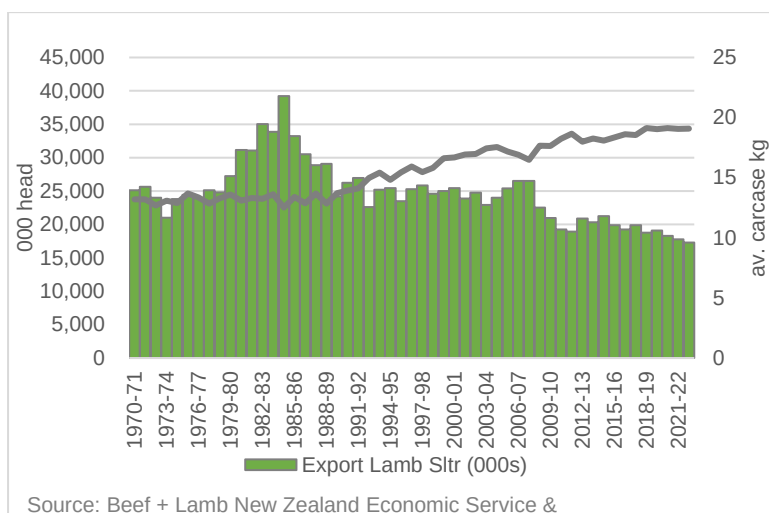
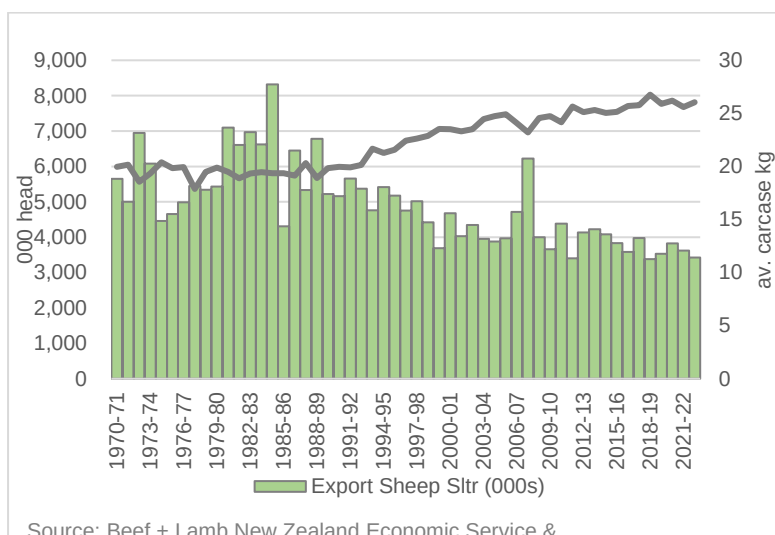


Figure 15. Average carcass weight of pigs in NZ from 1996 to 2018. Data sourced from Dobbinson (2020).

(A)



(B)



(C)

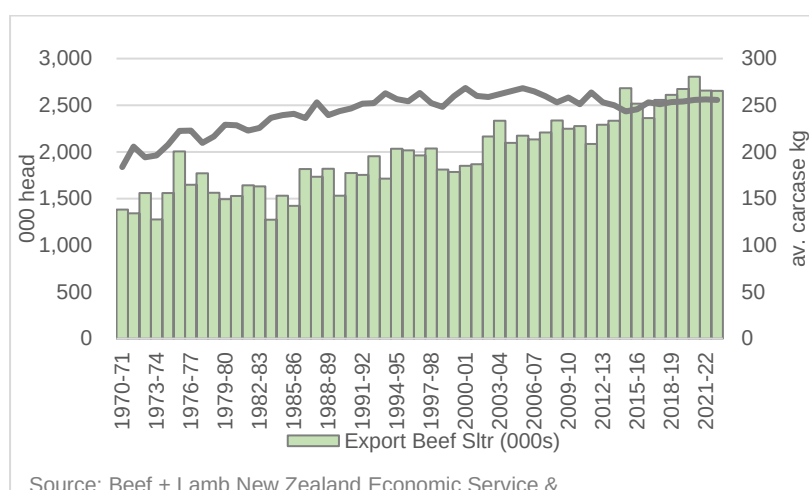


Figure 16. Average carcass weight (kg) for lamb (A), mutton (B) and cattle (C, dairy and beef) exported between 1970 and 2023 from NZ (right hand axis).

Note: up to 1992-93 lamb and mutton carcass weights were reported on a cold weight basis. From 1993-94 lamb and mutton carcass weights were reported on a hot weight basis. Conversion from cold to hot weight: use a general factor of cold weight divided by 0.972 for lamb and 0.973 for mutton.

Head space needs for livestock within crate pens

Opportunities to increase deck heights in NZ crates are limited by road rules around vehicle heights and although crate manufacturers have tweaked specifications to help reduce back rub, the limited head space still prevents animals from adopting normal standing postures. This also contributes to the lack of airflow through the crate, particularly during stationary periods.

Dobbinson (2020) considered that ‘market-weight’ pigs often rubbed against the ceilings of the pens when standing in their natural position, indicating that ceiling heights in NZ crates are inadequate for pigs (Figure 17).

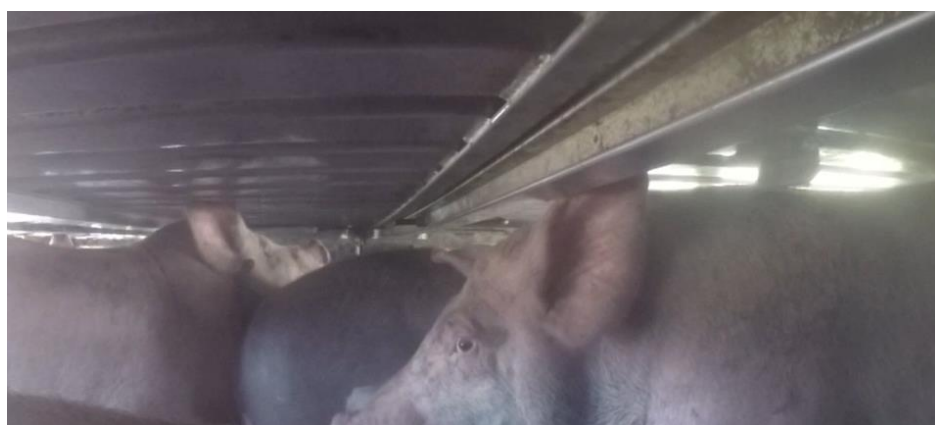


Figure 17. Market weight pigs being transported in a NZ livestock crate (Dobbinson 2020).

Most studies that have investigated the effects of space allowances for different livestock species, refer to the floor area (m^2/animal) and few studies have investigated the optimal head space or deck height. Furthermore, most studies that have investigated head height requirements during transport have focussed on behaviour or postures and have reported

on bruising or injuries, without measuring the effect on airflow when extra height is provided.

In early European Union reports, it was recommended that the minimum space between the head of an animal (when standing in a natural position) and the compartment ceiling should be 20cm for better ventilation (SCAHAW, 2002), and because of the need for unhindered movements and to reduce the risk of injuries (EFSA Scientific Opinion, 2011).

The Consortium of the Animal Transport Guides Project (2018) guidelines for cattle¹⁰ recommend the provision of at least 20cm clearance above the highest point of the back of the tallest animal and state that when hot weather conditions are expected, headroom should be increased by raising decks where possible, but not sufficiently to encourage mounting.

In the absence of enough scientific evidence, in the EFSA Scientific Opinion (2022), it is recommended that the space above the highest point of sheep is at least 15cm in vehicles with mechanical ventilation and 30cm in passively ventilated vehicles. For cattle, they recommended a deck height of wither height $\times 1.17 + 20\text{cm}$, which corresponds to at least 40cm above the withers for adult cattle. For a Holstein cow with a wither height of 146cm, the 17% above the withers equals 24.8cm. Adding this to the recommended 20cm of free space results in a height above the withers of approximately 45cm. For a Jersey cow (withers height 126cm) the corresponding number is approximately 41.5cm.

However, they suggested this may not be enough on warmer days in passively ventilated trucks as this calculation was based on a Danish pilot study using mechanically ventilated vehicles and outdoor temperatures of $\leq 20^{\circ}\text{C}$.

The Farm Animal Welfare Committee (FAWC)¹¹ advised the UK government in 2013 that headroom allowance was important to maintain animal welfare during transport. FAWC (2013) also recognised at that time that there was very little research regarding optimal head space but recommended the heights in Table 2 to be considered a minimum in any proposed policy reforms until further research was conducted.

¹⁰ [Guide to good practices for the transport of cattle - Publications Office of the EU \(europa.eu\)](#)

¹¹ Note: FAWC was renamed to the Animal Welfare Committee on 1 October, 2019

Table 2. Recommended headroom heights for different species from various sources.

	Jones et al. (2002)	FAWC, 2013 ¹²	EFSA Scientific Opinion, 2022
Pigs	-	9cm ¹³ above full standing head height Note: Later FAWC (2019) - 15cm above the highest point	-
Cattle	10cm above the highest point	Dairy, 20cm ¹⁴ Beef, 30cm above full standing head height	40cm above withers of the tallest animal ¹⁵ Note: EFSA (2011) 20cm above the withers of the tallest animal
Sheep	22.3cm above withers 5cm above the highest point (standing in a natural position) average weight of 65 kg - deck height 95.5cm	22cm above full standing head height ¹⁶	30cm above highest point (in naturally ventilated vehicles) or 15cm above highest point in vehicles with mechanical ventilation ¹⁷ (withers not used, as head is often maintained at a higher level)
All other animals (excluding poultry)		20cm above full standing head height ¹⁸	

Jones et al. (2003) found the head position of cattle during transport was related to the position of the ventilation slots as cattle tended to look out of the vents during transit. Since the highest part of an animal depends on the head position during transit, which will vary

¹² FAWC advice on space and headroom allowances for transport of farm animals, 2013.

¹³ Jones, T.A. (2003) Study to investigate the space above the head and shoulders of pigs and cattle when standing during transport. Defra Project AW0816 available at: <http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=12041#RelatedDocuments>

¹⁴ Lambooij, E., Reimert, H.G.M., van der Werf, J., Hindle, V.A. (2010) Compartment height in cattle transport vehicles. Available at: <http://edepot.wur.nl/157460>

¹⁵ Elmholt S, 2008. Considerations regarding suitable height above cattle during transport (in Danish language). Report from the Faculty of Agricultural Science, Aarhus University to the Danish Veterinary and Food Administration, 10th December 2008.

¹⁶ Jones, T.A., Look, A., Guise, H.J., Lomas, J. (2002) Head height requirements, and assessing stocking density for sheep in transit. Veterinary Record, 150, 49-50.

¹⁷ Based on recommendations from the Consortium of the Animal Transport Guides Project (2018).

¹⁸ SCAHAW. (2002) The welfare of animals during transport (details for horses, pigs, sheep and cattle). Scientific Committee on Animal Health and Animal Welfare.

depending on behaviour, Jones et al. (2003) suggested the head space is better defined from a fixed point (e.g., shoulder or back). The headroom required can then be given as a direct measure for the size of animal, (either cm above the shoulder/back or cm of deck height), or as a percentage of the floor to shoulder/back height for that species, making it easier to calculate height requirements.

Jones (2003) observed cattle (average weight 548kg, range 409-702) transported in a one and two-deck vehicle (deck height 195 and 170cm respectively) and pigs (average 103kg, range 98-111kg) in a two and three-deck vehicle (119 and 93cm respectively). The average head height of cattle in the head up position in the two-deck vehicle was 151.4cm, or 18.1cm above the shoulder and 21.1 percent of the floor to shoulder height (inclusive of the recommended 10cm).

It was concluded that the national average deck height in two-deck vehicles (162cm) would satisfy the height requirements for cattle with 133cm shoulder height, but larger cattle would require a 186cm deck height to travel with their heads up. It was recommended these larger cattle would be better transported in a single deck vehicle. This was based on the transport code of practice recommendations that during transport, animals should be able to stand in their natural position with space for air circulation, and that the space above the highest part of cattle should be at least 10cm, and at least 5cm above pigs and sheep.

For pigs, Jones (2003) found the prominent head position during transit was down (66% of observations) and was related to the bracing posture they adopted to maintain balance. Pigs started to sit down after 24 minutes and then lie down after 37 minutes. The highest head position in the three-deck vehicle was 81cm, or 9cm above the average back height and 19.4% of the floor to back height (inclusive of the recommended 5cm).

It was concluded that the average deck height for three-deck vehicles in UK (average 103cm) satisfied the requirements for headroom in pigs up to 111kg. Although temperature and humidity were measured in the pens, due to the design of the study, it was not possible to conclude anything about the effects of increased head space on ventilation.

For sheep (average weight, 65kg), Jones et al. (2002) found that the majority (80% of observations) held their heads above the withers during transport compared to level or below the withers (10% of observations), and the average head height when adopting head up or level positions was 90.5cm and 73.2cm respectively. It was concluded that the required height above the withers (to allow for the head up position) was 22.3cm (or 30.5% of the floor to wither height) and recommended that for sheep with an average weight of 65kg, a deck height of 95.5cm is required.

Jones et al., (2002) cited data from a UK report (Milton Keynes, Meat and Livestock Commission, 1997) suggesting four-deck vehicles were not suitable for transporting adult sheep due to insufficient head space. The average heights for single, double, triple, and four-deck vehicles were 1680, 1020, 990 and 840 mm, respectively (minimum heights ranged from 840 to 700 mm). The percentages of transporters with decks with heights greater than 950mm were 93%, 78%, 70% and 6% of single, double, triple and four-deck vehicles, respectively.

There is also the practical aspect of the driver determining the height at the withers of the tallest animal to consider. Visser (2014) outlined an equation that could be used to determine the expected height of pigs with different weights: $\text{Height(cm)} = 38.8639 + 0.4272 \text{ Weight(kg)} - 0.0008375 \text{ Weight(kg)}^2$. However, estimating the height of livestock immediately prior to loading should not be the full responsibility of the driver. Farmers and stock agents need to ensure animals are drafted according to height prior to loading.

Holleben et al. (2003, cited in Lambooij et al., 2012) observed more severe bruising at the tail and back for bulls and at tail and perianal positions for heifers when the space above the animals was fixed at 10cm above the withers to prevent mounting. It was concluded that the ceiling should not be fixed lower than 20cm above withers.

Lambooij et al. (2012) reported head butting (i.e., the head touching or butting the ceiling) of dairy cattle and veal calves three ceiling heights (10, 15 and 20cm above the withers of the tallest animal) during short (2 hour) road journeys. However, no head butting was observed when a separate group of heifers were transported 27 hours with a clearance of 40cm above the withers. Therefore, Lambooij et al. (2012) suggested providing a clearance of more than 20cm above the withers during transport of cattle. However, unfortunately no environmental conditions were measured to assess the impact of the different heights on ventilation.

The NZS 5413 standard, which requires a minimum height of 950mm between decks for transporting calves is a similar deck height recommended for a 65kg sheep (Jones et al., 2002). While it appears efforts are made to avoid transporting calves on crates with a four-deck configuration in NZ, and during discussions with transport operators it was considered no calves are transported on the top decks anymore because of the shelter regulations, it appears that many are still transported in crates that do not meet the 900/950mm requirement.

The deck heights in overseas studies cited by Dobbinson (2020) were between 900 and 1100mm. In NZ, the average deck heights for a newly built crate with a three- or four-deck configuration are much less (Table 3). There are various dimensions, but for example, a new crate currently being built with 17.5-inch wheels, the heights are follows: first cattle deck, 1600mm; second deck cattle, 1655mm, with sheep decks, from bottom to top, 740mm, 860mm, 803mm and 850mm respectively.

The data presented in Table 3 only includes new crates. For older crates, deck heights will vary, with some likely to be lower given recent design changes incorporated into new builds in an attempt to increase deck heights.

Table 3. Average deck heights (mm) for newly built two, three and four-deck livestock crates in NZ. Calculated from new design plans provided by NZ crate manufacturers.

Crate Configuration		Deck 1	Deck 2	Deck 3	Deck 4
Truck	Two-deck cattle	1584	1509		
	Three decks - two sheep, one cattle	760	870	1530	
	Four-deck sheep	718	827	687	749
Trailer	Two-deck cattle	1610	1566		
	Three decks - two sheep, one cattle	733	870	1577	
	Four-deck sheep	744	832	721	788

Following the 2021 inquiry, the European Parliament considered that unclear requirements for headroom may often lead to situations where animals are not able to stand in their natural position, undermining the objective of protecting animals during transport and insisted that more scientific evidence is needed to provide accurate recommendations.

In NZ livestock crates, deck heights are likely to compromise air flow, especially in the lower decks. It is difficult (impossible in some circumstances) for transport operators to meet standards requiring animals to adopt normal standing postures, have freedom of head movement, display normal behaviour and stand without contacting the ceiling, as shown in Figures 18-20.

However, evidence-based thresholds for species-specific head space requirements for optimal airflow in livestock crates under NZ conditions remains a gap in knowledge. There is a need for further research to determine optimal deck heights and industry led strategies to address this issue.



Figure 18. Lambs (approximately 48-50kg) loaded (11/pen) into a 3-deck crate configuration before and after the floors were closed down.



Figure 19. Ewes loaded into the second deck of a 3-deck crate configuration before and after the floors were closed down.



Figure 20. Steers (approximately 600kgs) loaded (4/pen) into the lower deck of a two-deck crate configuration before and after the floors were closed down.

Proposed next steps:

- During the standards review process, clarification of what is meant by 'normal/natural postures' and specific measurement points of the animal should be included, e.g., the highest point of the back or the head, and the head room required between the head and the ceiling.
- Research is needed to assess the impact of head space on livestock behaviour and environmental conditions within livestock crates to ensure optimal ventilation and allow normal standing postures, based on an understanding of the different needs of each species.

6.3 Covers and Shelter

NZLTA 2.2.5

All open crates shall be fitted with a cover which **must be used when livestock are transported on the top deck**.

The cover shall be constructed and secured in such a way that it cannot dislodge, flap or create excessive noise during transportation.

MPI Regulation 36 - Shelter requirements for young calves during transportation

A person in charge of a vehicle must not transport a young calf off farm for the purpose of sale or slaughter or as a result of sale unless:

- a) the vehicle provides shelter that-
 - i) is **ventilated** to the extent that there is no threat to the health or welfare of the calf due to insufficient ventilation; and
 - ii) **provides protection from adverse weather**, including precipitation and extremes of heat and cold; and
 - iii) enables the calf to **stand up and lie down in a natural posture**; and
- b) the person ensures that **faeces and urine do not accumulate in the vehicle** to an extent that may pose a threat to the health or welfare of the calf.

DeerQA Transport Programme

The roof must be purpose built to secure the deer within the pen and prevent stress. It must be constructed and secured in such a way that it cannot dislodge, flap, or create noise when deer are being transported.

NZLTA standards require all open crates to be fitted with a cover, which must be used when livestock are transported on the top deck. Covers allow the top of the crate to be open, which provides ventilation to the upper decks, while preventing animals from jumping out over the top deck. Some cover designs provide some degree of shade in summer, but the materials used are not waterproof or designed to protect livestock from rain /snow or provide high levels of protection from solar radiation (Figure 21).

There are materials on the market that provide different levels of protection against solar radiation that could be used to provide better protection against the sun when livestock are transported on the top deck. There have been a number of studies undertaken that highlight the importance of shade and the impact on reducing heat load in dairy cows (e.g., Schütz et al., 2009).

Schütz et al. (2009) found that cows preferred shade that provided more protection from solar radiation (50 and 99% blockage versus 25%) and showed behavioural and physiological changes associated with increased heat load. They reported small differences in THI beneath

the different types of shade, but the black globe temperature, which incorporates the effects of solar radiation, decreased by 1°C per 25% blockage.

Dobbinson (2020) found high levels of THI in commercial units transporting pigs. It had been predicted that airflow would be better on the upper deck, as previous work had shown the majority of pigs dead on arrival at the plant were on the bottom decks. However, high THI levels (greater than 70) on 69% of the journeys were found on both the upper and lower decks. It was suggested the use of covers, rather than using the top deck floor as a ceiling, may improve conditions, since the aluminium floors conduct heat from the sun. However, covers would need to incorporate sufficient protection from solar radiation, with pigs in particular being susceptible to sun.

Driver compliance with cover requirements is often lacking because of the inconvenience of fitting them after loading and removing them for unloading. Therefore, it is not uncommon to see truck and trailer units carrying livestock on the top deck without a cover (Figure 22) and, at times, animals attempting to escape/jumping out over the top deck. This exposes livestock to the weather and the risk of serious injuries or death, from falling or being hit by low bridges, and poses a risk to the public if an animal falls from the vehicle.



Figure 21. The two most common materials used for covers on the top deck of livestock crates.



Figure 22. Beef cattle loaded on the top deck without the cover fitted.

Although for some transport operators it is a company policy to always use covers, it is difficult to enforce and there is a need to increase compliance across the industry. One solution some companies have adopted is the use of the Cratesafe™ system¹⁹ manufactured by Landquip, NZ (discussed further in Section 9). This system has benefits for driver safety by preventing the risk of falls when working on the top of the crate, but it also ensures covers are used, as per the industry standards, since it is not possible to drive without having the covers folded down (Figure 23). CrateSafe™ systems use a product that provides 47.4% shade factor²⁰.



Figure 23. Livestock crate fitted with the CrateSafe™ covers. Photo provided by Landquip, NZ.

The shelter regulations for transportation of calves requires the provision of shelter that is sufficiently ventilated and protects calves from adverse weather, including precipitation and extremes of heat and cold. During discussions with transport operators, they expressed concerns about the difficulties complying with this regulation and ensuring calves are kept dry, while also providing enough ventilation.

The current crate design and covers used make it difficult to meet these regulations and further work is needed to develop a design or system that provides both sufficient shelter and ventilation. Some operators have experimented with waterproof covers for transporting calves, such as the one shown in Figure 24, that can be fitted and removed easily. As mentioned previously, many overseas crate designs have a solid roof on the top of the crate, but such designs would rely on more airflow through the wall openings or require mechanical ventilation.

¹⁹ [Cratesafe](#)

²⁰ [Euromesh 4500 | Heavy Duty European Transport Cover Mesh Fabric \(straitline.co.nz\)](#)



Figure 24. Removeable, waterproof cover remotely operated from the ground.

Proposed next steps:

- Initiatives to increase driver compliance with industry requirements for the use of livestock crate covers should be developed.
- Research is needed to develop new technologies and materials for covers that provide appropriate shade and shelter.

6.4 Flooring and Ramps

Code of Welfare – Minimum Standard No. 2 and 3

Conveyances and containers must be designed so that the **faeces or urine from animals on upper levels do not soil any animals**, feed or water on lower levels.

Recommended Best Practice All flooring surfaces on ramps and in facilities should incorporate a non-slip material to aid grip.

Stock Crate Code 4.5.3

Grip-bars

Suitable for any species although grating is preferable on all decks. Consideration should be given for transporting **sheep and young calves**. (NZS 5413 states for **cattle only**)

Grip bars may be fitted to the **third deck only**. The spacing must be no greater than 100mm between bars. **All other decks must have suitable grating** – ie, grating required on the bottom floor, the 2nd multi species deck, and the 4th deck. Grip bars are not acceptable on these decks.

Any grating must provide suitable foothold for stock and not have a smooth surface.

NZS 5413 standard 4.5.3.1 and 4.5.3.2

Grip bars shall be fixed to floors in such a way that lateral and longitudinal runners form a mesh pattern comprising of openings no greater than 300x300mm internal measurement.

Grip-bar runners shall not be less than 8mm diameter. Note: Cognisance shall be given to the **potential for damage to be caused to the animals hooves** from the use of other than round section or round edged material for grip-bar runners.

NZS 5413 standard 4.5.1

To provide a suitable foothold for stock and keep stock clean, **floors shall be fitted with gratings manufactured of impervious material** having a finished surface such that animals do not damage their feet. Gratings shall have a maximum opening of **19mm²** (4.5.2.1)

NZS 5413 standard 4.3

All doors and doorways shall be designed to provide a **minimum opening width of 900mm** (requirement is **700mm** in Stock Crate Code) and, when opened, shall provide unobstructed exit and entry for stock.

Stock Crate Code 4.7

The gradient of ramps must not be too steep. Stock **must be able to ascend and descend without losing footing**.

Note **NZS 5413, 4.7.1** reads: The gradient of internal races, where fitted **shall be gradual** enough for stock to ascend and descend **without injury**.

The pen floor which forms the ramp to the top cattle deck may be in the form of steps. This cannot have grating or grip bars affixed, and is suitable, as is, only for cattle.

If young calves, sheep and pigs are to be carried in this pen there must be some temporary removable grating which can be laid on top of it. The pen floor which forms the ramp to the first sheep deck may have grip bars for better grip provided they are modified with closer runner spacing as in 4.5.3 above.

All other pens on this deck must have grating. The front pen on the 2nd multi species deck on some trailers can also be used as a ramp. If grip bars are on this pen then temporary removable grating must be used in this pen when carrying stock.

DeerQA Transport Programme

The surface on which deer stand must: (a) ensure secure footing (b) ensure safety and freedom from injury (c) ensure cleanliness (d) ensure adequate drainage.

The design of floors and loading ramps can have a significant effect on livestock welfare (Grandin, 2008; Lapworth, 2008). Flooring surfaces on ramps and in pens need to incorporate a non-slip material to aid grip and prevent livestock slipping /loosing footing and injuries, and to facilitate ease of movement to avoid stress.

Internal ramps within NZ livestock crates

When designing ramps for loading and unloading livestock, it is important to understand the visual abilities of the different livestock species being transported. Because livestock are prey animals, their eyes are located on the sides of their heads, giving them a wide field of vision for detecting predators. However, this means they have limited depth perception, which makes it difficult to navigate walking up and down slopes. For example, cattle only have approximately 60 degrees of vertical vision, but have a large field of vision (approximately 330°) with a blind spot directly behind them (Adamczyk et al., 2015).

Therefore, the correct angle of slope on ramps is very important to promote successful movement and reduce baulking and backing up behaviour, which leads to increased physical intervention and use of electric prodders in cattle (Grandin, 2008). Willson et al. (2021) also described the importance of other environmental factors such as shadows and noise that cause baulking behaviour and impede animal movement. In addition, gates should be able to close without having to force livestock into the space and use electric prods.

Different drivers use different techniques and degrees of force that contribute to stress in livestock during loading and unloading, and in NZ, electric prods are still permitted and commonly used for loading cattle. This is likely due to time pressure on drivers to keep to tight schedules, a lack of education and crate design features such as steep ramps and tight spaces for animals to orient themselves when drafted into a pen. Furthermore, compliance with the electric prodder regulations that require the animal to have sufficient room to move away from the prodder are difficult to enforce.

Pot-bellied vehicles used in North America have steep internal ramps (up to 40 degree slope) and 180 degree turns. This creates difficulties handling livestock during loading and unloading and causes increased stress and use of electric prodders (up to 32%), and extended load and unload times (Ritter et al., 2008; Torrey et al., 2008).

Door openings and internal ramps also need to facilitate unobstructed entry to reduce injuries (Figure 25). In Australia, entry and exit doors are 1200-1500mm wide and doors on internal pens are at least 1200mm, and up to 2000mm wide (Lapworth, 2008). Lapworth (2008) considered this was an improvement from gates that were previously only wide enough for a single cattle beast to fit through, which caused more bruising and injuries.



Figure 25. An example of a UK crate design with a wide ramp and entry for loading and unloading.

It was also considered pens running the full length of the vehicle, without a central longitudinal division reduces the number of gates, which reduces the risk of injuries, provides more room for animals to move away from aggressive conspecifics, helps improve airflow, reduces stress and makes loading and unloading quicker (Lapworth, 2008). Operation of gates is also the cause of many driver injuries (see ACC statistics in Section 9 below). Grandin (2008) considered ramps should be single or double file (never an animal and a half wide) to prevent animals becoming wedged together.

The NZS 5413 standard requires unobstructed exit and entry for livestock and all doors and doorways to provide a minimum opening width of 900mm when opened. Whereas the Stock Crate Code requires a minimum width of 700mm. Although these measurements are minimum requirements, gates and ramps in NZ livestock crates are designed so that one cattle beast can fit through at a time.

Furthermore, from discussion with transport operators, some newer crates are being built with lighter, narrower ramps making them easier for drivers to lift. The optimal width of ramps and other exit/entry points, and number and design of partitions within NZ crates to meet the different sizes and needs of each species should be determined from an animal welfare and driver safety perspective.

Industry guidelines, currently being developed for publication, also state that facilities should provide uniform lighting directly over approaches to the ramp, with brighter lighting inside conveyances or containers, to minimise baulking and should be aligned to avoid loading into the sun. Shadows and bright spots/light reflections cause livestock to baulk and refuse to move, therefore, eliminating these from the environment improves animal movement (Grandin, 2008).

All newly built NZ crates are fitted with lights for loading at nighttime, but not all older crates still in use have lights installed. This should be a minimum requirement for all crates to reduce injuries and stress for both livestock and drivers and facilitate ease of movement during loading and unloading.

Although there are no minimum standards that stipulate the maximum slope of internal ramps in livestock crates, the transport code of welfare states that as a guide, livestock generally manage loading and unloading best when the maximum slope does not exceed 20 degrees, except for young animals. For livestock younger than one week of age that are expected to walk up or down ramps themselves, the maximum slope is 12 degrees. This is also the wording being incorporated into new industry guidelines for external loading facilities, which also states that ramps should be constructed appropriate to the species.

A maximum slope of 20 degrees is also recommended by Grandin (2008) as well as other industry guidelines, such as the Australian Livestock and Rural Transporters Association (ALRTA)²¹ and the Transport Quality Assurance Program for pork in the US²², which states that lower angled ramps, such as 10-13 degrees, are much easier for pigs to use. In the EFSA Scientific Opinion (2022), it is recommended that a minimum slope of 15 degrees is used for pigs.

The Consortium of the Animal Transport Guides Project (2018) stated that a maximum ramp angle of 20 degrees is appropriate for cattle providing it has non-slip floors and appropriate cleats at 300mm intervals, but calves require lower gradient loading ramps. In a NZ study, Bremner et al. (1992) reported that 7.2% of calves fell with a ramp incline of 4.2 degrees, whereas 80% fell with a ramp angle of 18.8 degrees.

In NZ, unless external multi-deck ramps are available at loading facilities (Figure 26), internal ramps within the current crate design require livestock to load and unload from the top deck using a ramp with an incline of approximately 30-35 degrees for new crates and up to ≥40 degrees in various older crates (Figure 27). Therefore, in both new and old NZ crates, internal ramps are much steeper than the recommendations for external ramps. Ramps are designed for ease of cleaning, weight and the ability to reach multiple decks for different species, with no science-based guidelines around optimal dimensions to promote good welfare.



Figure 26. Multi-deck loading ramp.

²¹ [RL13654 ALRTA-Ramps-Guide-FINAL-WEB-13.8.15.pdf](#)

²² [TQA V8 Handbook 12.08.22 Final.pdf \(porkcdn.com\)](#)



Figure 27. Driver setting up the internal ramp for loading and beef cattle being loaded onto the top deck.

In addition, Grandin (2008) recommended step rises on concrete ramps for cattle should not be greater than 100mm with a 300mm tread, and a rise of 80mm for pigs. A level area of at least 3m minimum at the top of the ramp is also recommended to allow animals to gain their footing before descending the ramp, especially for extensively raised cattle that often exit quickly (Grandin, 2008). The ALRTA guidelines also recommend ramp stairs have a 100mm rise and that treads are 450mm for cattle, with 50mm rises and 250mm of treads for sheep.

Steps on internal ramps within NZ livestock crates are steeper and narrower than these recommendations for cattle. New crates are built with a 230mm rise and a 60mm tread. This combined with the steep slope means these ramps are unlikely to meet the industry standards and poses a higher risk of injuries, issues loading livestock as discussed above (e.g., unnecessary use of electric prods) and poor welfare during loading and unloading.

Once again, there is no 'one size fits all' solution and although some farms and meat processors have multi-deck loading ramps to help facilitate direct loading onto the upper deck, this should be a requirement for all facilities, including saleyards and farms.

Flooring

The floors in NZ livestock crates are designed to be flexible to allow different deck configurations for different species and at the same time be watertight to prevent animals from being soiled by faeces or urine produced by the animals on the decks above them. Surfaces are designed to provide grip to minimise the risk of animals slipping, with weight, ease of cleaning, drainage and effluent management being important design considerations to meet weight limits and effluent regulations.

On the bottom deck, the flooring is made with steel mesh, designed to allow effluent to drain directly into a shallow tank below the floor (Figure 28). Upper decks are usually made of perforated aluminium with oval or round punched holes to allow effluent and rainwater to drain into the holding tank (Figure 29). Grip bars are still permitted on the third deck and

are used mainly by transport operators in the North Island who generally transport more cattle and less sheep compared to the South Island (Figure 30).

Industry standards for grip bars are contradictory. The NZS 5413 standard states grip bars are an optional foothold for cattle only, whereas the Stock Crate Code says they are suitable for any species, but *consideration should be given for transporting sheep and young calves*.



Figure 28. Steel mesh floor on the bottom deck of a new NZ livestock crate.



Figure 29. Perforated aluminium floor on the second deck of a new NZ livestock crate.



Figure 30. Grip bars (115mm gap) incorporated into the top deck of a new two-deck cattle livestock crate in NZ.

The material from which the flooring is made can influence the temperature within crate pens. For example, Dobbinson (2020) suggested one of the factors that caused high THI levels for pigs was the aluminium floors conducting heat from the sun being situated so close to the pigs when the floors are closed down acting as a ceiling. It is also important to consider that some species will hesitate when entering an area with unfamiliar flooring materials that introduce both tactile and auditory stresses like a livestock crate (Dobbinson, 2020; Grandin, 2008).

Animal comfort has not been an important factor taken into consideration when designing floors and surfaces for multi-purpose crates. One of the challenges is that the 'one size fits all' design does not meet all of the needs of the different species being transported. For example, different preferences for lying vs. standing depends on species, age and health. Pigs and calves are more inclined to lie down during transport. Pigs generally prefer to lie down after a period of standing if the conditions are suitable (Dobbinson, 2020; Sutherland et al., 2009), but this can also depend on journey length and environmental conditions.

For deer, the majority of specialist transport operators provide rubber mats placed on top of the mesh floor to prevent damage to their feet, which occurs on other floor surfaces. For example, perforated floors often have sharp edges, especially when they are new. These sharp surfaces may pose an increased risk of injuries, especially for species that have no coat covering for protection (e.g., pigs). In addition, during discussions with transport operators, it was acknowledged that over time these floors wear down and lose grip.

The steel mesh floors might provide the best surface of the three currently used, however there are trade-offs made between animal comfort, weight of the material used, effluent management and ease of cleaning. Importantly, no scientific research has been undertaken to assess the welfare impacts of the current floor surfaces or investigate the optimal floor surfaces for NZ livestock crates. The DeerQA Programme states that *the ideal flooring to meet this standard is steel or alloy mesh with a maximum aperture of 19mm x 19mm. This type of flooring is required for both single and double deck crates.*

Grip bars appear to be the least likely to meet good standards of welfare and some transport operators questioned why they were still permitted. They considered that cattle cannot stand with their hooves in a flat position, causing them to move around more as they attempt to maintain balance and that they are not suitable for sheep to stand comfortably. Sheep are also at risk of lying in excess effluent because of the design. The only benefit of grip bars appears to be ease of cleaning and reduced weight (i.e., weight of the material as well as the ability to lift them up so that the effluent drains off) rather than preventing injury, providing a comfortable, flat surface to stand or lie and promoting good animal welfare.

Lying behaviour during transport is sometimes mistaken by untrained observers as a sign of the livestock being 'relaxed or content', however it can often be in response to adverse conditions, such as heat stress. Also, as mentioned previously, if the head space is not sufficient to allow animals to stand in a normal posture, or as animals become fatigued, they may be forced to lie down.

Dobbinson (2020) suggested that unless the loading process was prolonged, the majority of the pigs would remain standing throughout the period during which they were being loaded. Other factors that can prevent lying regardless of an animal's motivation to lie down, include road conditions, suspension quality of the vehicle, stocking density and driving quality.

It has been suggested that cattle stand in a way to maximise the surface area exposed to the environment and increase the airflow around the body (Ansell, 1981). Standing may also be a response to avoid lying on a cold floor surface (Goumon et al., 2013). Dobbinson (2020) considered that when a pig lies down in lateral recumbency, a large part of its body surface is exposed to the cooling effect of the floor. This results from body heat being conducted away from the pig by the aluminium or steel mesh flooring. Additionally, in a lying posture, there is an increase in the amount of air space above the pig that would allow more air movement, increasing the opportunity for increased evaporative cooling (Dobbinson, 2020).

There is overwhelming scientific evidence that dairy cattle prefer soft and dry surfaces (e.g., Fisher et al., 2002; Schütz and Cox, 2014). In some countries overseas, it is common practice to use bedding (e.g., woodchips, sawdust or straw), especially for young animals during colder months. The Canadian Code of Practice²³ requires suitable bedding such as straw or wood shavings or appropriate mats in vehicles to assist in absorbing urine and faeces, provide better footing for the animals and protect them from the hard flooring.

During discussions with transport operators, it was considered the use of bedding in NZ crates would be impractical because of biosecurity issues and managing effluent. Studies have shown the benefits of bedding materials (i.e., comfort and non-slip properties), however when bedding gets wet through the absorption of condensation and urine it can be detrimental to welfare (Sutherland et al., 2009).

In NZ livestock crates, rainwater entering through wall openings and open roof tops would create further challenges keeping bedding clean and dry. One exception could be for calves being transported shorter distances with shelter from wet weather, as required by the regulations.

When soft, dry bedding is not practical, adding rubber matting on top of hard surfaces is beneficial for animal welfare (e.g., Schütz and Cox, 2014; Schütz et al., 2015). There is currently MPI funded research being undertaken to investigate the impacts of rubber mats on calf welfare during transport. Therefore, the extent of this literature and the benefits and options for rubber matting will not be discussed further in this report.

However, consideration will need to be given to the findings from the current project as well as the benefits for other species and age groups, given the number of studies that have investigated rubber matting, as well as the practicality. The technology for rubber matting as a surface for various purposes for livestock and horses has advanced significantly in

²³ Recommended Code of Practice for the Care and Handling of Farm Animals – Transportation. 2001. Canadian Agri-Food Research Council, Ontario, Canada.

recent years. It is possible with new innovative products and further developments of different materials, lightweight options more suitable for practical use in livestock crates will be developed. Indeed, deer transporters in NZ have adjusted to using and maintaining rubber mats.

Proposed next steps:

- To ensure consistency with industry recommendations for external loading ramps, internal ramps should not exceed a slope of 20 degrees for cattle and the more gradual inclines recommended for other species, with appropriate rise and tread dimensions.
- A minimum standard for lighting systems in livestock crates should be established to ensure drivers have sufficient lighting to safely load and unload livestock and undertake the required inspections of livestock during the journey.
- To improve animal welfare, comfort and the ability to maintain balance, the use of grip bars on flooring should be reviewed.
- Research is needed to develop new technologies and different construction materials to improve the design of floors, ramps and door/gate openings, for improved animal comfort and ease of movement.
- The installation of multi-deck loading ramps at all facilities, including meat processors, saleyards and farms, would help facilitate direct loading onto the upper decks. Loading facilities at saleyards, farms and processing plants could be improved with regular maintenance and standards better enforced through assurance programmes.

7. Number and age of livestock crates in NZ

During our discussions with transport operators, crate manufacturers and NZLTA, most were of the view that livestock crates have a life span of around 20 years and there are approximately 3000 livestock crates in NZ. Due to the relatively long life span of livestock crates, there is still a variety of designs on NZ roads.

There are 2682 crates registered under the NZLTA programme (Table 4). It is difficult to determine the exact number of crates in NZ, because not all crates are subject to the accreditation programme. The NZLTA programme requires crates to be inspected biennially by AsureQuality against the Ia Ara Aotearoa Stock Crate Code for Transportation of Livestock and certified under its Crate Accreditation Programme.

Table 4. Livestock crates currently registered in the NZLTA Programme. Summarised from data provided by NZLTA (August, 2023).

Age of crates (years old)	Number of crates
20 to 30 yrs	118
15 to 20 yrs	217
10 to 15 yrs	185
10 yrs or less	1353
5 yrs or less	651
Unknown	809
Total number of crates	2682

The manufacture date for 809 registered crates is unknown. These are likely crates manufactured prior to 2007 when the NZLTA programme started (personal communication, NZLTA), therefore the actual number of older crates on the road may be higher.

Some MPI VS veterinarians we engaged with considered some older and uncertified crates they see arriving at meat processing plants need maintenance to prevent animal welfare issues. For example, holes/gaps in floors and internal ramps that pose the risk of animals breaking a leg.

Many of the uncertified crates are older and used by small operators or farmers and have the potential to remain in operation for many years without being inspected. Crates that are not subject to an accreditation programme may pose a risk to driver safety and animal welfare if they are not properly maintained.

Furthermore, many transport operators expressed concerns that the current accreditation system is insufficient, and that when audits are conducted there appears to be a lack of knowledge and little effort to assess animal welfare risks. These operators expressed frustration with the current system, including the costs they incur and that it doesn't apply

across the board. They considered that the system needs to be reviewed (discussed further below).

Proposed next steps:

- The livestock crate accreditation system should be reviewed, with an improved focus on animal welfare. Additionally, all livestock crates on NZ roads should be subject to the accreditation programme, not only those that are part of the NZLTA programme. This could be an expectation and requirement set by meat companies.

8. Findings from stakeholder engagement and workshops

Engagement with transport operators, drivers, meat processors, livestock industry bodies and crate manufacturers were undertaken throughout the project by way of online and face-to-face meetings and attendance at livestock industry meetings. A series of workshops targeted at gaining input from transport operators across the country was also facilitated by Animal Welfare Solutions Ltd. Valuable insights were also gained from shadowing drivers during loading, transport and unloading of livestock, visits to processing plants and meetings with MPI VS veterinarians.

In late April 2023, as part of planning the workshops, we engaged with the NLTSG to establish a list of transport operators across the different regions, to ensure the industry was well represented and ascertain the best locations to hold workshops. We communicated to NLTSG our aim to seek input and engage with as many transport operators as possible in an open, solutions-focused discussion.

Workshops took place over June and July 2023 in Ashburton, Gore, Hamilton and Palmerston North, the regions identified as achievable for the majority of operators to attend. Invitations were sent to approximately 100 transport operators identified by NLTSG and 65 attended across the four workshops.

We encouraged discussions around how the current crate designs help to meet the standards and requirements related to animal welfare set out in the NZLTA Programme Manual, the Stock Crate Code and the transport code of welfare in regards to seven main areas; ventilation, space, covers, shelter, flooring and ramps, health and safety. We discussed which design features could be improved to meet the standards and the challenges and opportunities to improve welfare and driver safety.

Understandably, concerns associated with the wider supply chain that impact on animal welfare were raised repeatedly during these discussions, highlighting the importance of addressing these issues alongside crate design improvements. Although not directly related to the crate design, a summary of these concerns from transport operators is also included below.

“If you address the other issues across the supply chain then some changes will improve animal welfare”.

The summary below includes input from all stakeholder discussions and from transport operators during the workshops. This section presents an account of what was explicitly stated and statements were taken at face value without interpretation or analysis.

General comments and key points raised

In general, most transport operators considered the current crate design was fit for purpose and there were few animal welfare issues, however some agreed current crates were not fit for all purposes. There was a strong focus on concerns about back rub (i.e., crate height issues) and other welfare issues that result in transporters being issued infringements, rather than wider animal welfare issues (e.g., journey times, heat stress, airflow and space) until discussion on these other topics were encouraged.

When asked if the industry has possibly lost its way with respect to image and appearance of the trucks instead of practicality and animal welfare, most operators disagreed.

It was considered that multi-purpose livestock crates are needed because the livestock being transported throughout the year varies (e.g., cull cows, bobby calves, prime stock), making it difficult to have species specific crates in NZ. The cost of changing to new crate designs was a significant concern. Some thought very few deaths occurred compared to past years. However, it was highlighted during the workshops that death is not an accepted measure of animal welfare. Additionally, some considered deaths were often under reported.

“In the big scheme, there are not a lot of deaths or prosecutions compared to numbers of animals moved”.

“We’ve got the crates we want already”.

“The life of a stock crate is approximately 20 years so if the laws change its going to take 20 years to make any changes”.

All stakeholders we engaged with agreed that the NZS 5413 standard was outdated and that NZ crate designs had superseded this code, with many improvements made over the years. They agreed the code needed to be reviewed and updated. Many also agreed the standards in the NZLTA Programme Manual and the Stock Crate Code needed reviewing and updating and should specify requirements around animal welfare.

All crate manufacturers stated that they can build anything the customer requires and that sometimes there are trade-offs to be made with weight and structural requirements, but most things can be achieved. Recent design improvements have focused mainly on reducing back rub including drop down floors to increase deck heights, flattening and smoothing all surfaces so that there are no sharp edges, as well as health and safety features. The cost of a crate is currently approximately \$100,000 to \$120,000 for a truck and up to \$150,000 for a trailer, making it close to one million dollars to put a unit on the road, including the cost of the truck and trailer.

Common concerns raised repeatedly, and discussed further below, included:

- livestock not being stood off pasture and prepared for transport as required by the farmer, with most operators agreeing that if this was addressed, most of the welfare issues would go away;
- the lack of driver, farmer and stock agent education around a range of issues; and
- who will pay for any potential changes, with concerns that the payment system is largely dictated by meat processors and transporters are *“the meat in the sandwich”*.

“Animals load better/calmer, and travel and unload better when they have been stood off pasture”.

“The issue is the famer wants them going to the works or saleyards full bellied”.

Some considered the time off feed needed to be regulated by government rather than being a recommendation, so that it could be enforced. Some meat processors have restrictions on the number of times animals can be washed and can refuse to take extremely dirty animals, resulting in sending them back to the farm at the farmer’s cost. Note: this poses a welfare concern around additional handling, loading, transport and unloading. It was discussed how

some meat processors are considering incentives (e.g., a premium) for presenting clean animals.

There was also a significant concern about the lack of drivers, an aging workforce and a lack of experienced drivers. It was considered that it is difficult to attract drivers into livestock driver roles, due to the number of regulations and fines/infringements, health and safety and issues with farmers not complying with requirements.

Many operators considered going back to a reduced number of decks would be an obvious solution to some of the issues raised around space requirements, especially for ewes and calves. However, they would need to be paid appropriately (e.g., unit rates would have to change) and the transition would be a challenge. Some considered that if regulations change requiring calves to be older before they can be transported (e.g., 10 days old), three decks would not allow enough height.

Additionally, for some operators, farm-to-farm cartage was approximately half of their work and this cost would have to go back to the farmer. Others commented that filling back loads could be difficult with less decks.

“We can go back to single deck cattle and double deck sheep or any combination of things but who is going to pay?... it will require too many trucks on the road and we already have a lack of drivers.”

“NZ is small compared to other countries and probably can’t afford to have dedicated trucks – this would be cost prohibitive for this country”.

“For bigger animals, the current design allows us to single-deck cattle and two-deck sheep (if compensated), allowing us to still double deck small to average cattle and store lambs”.

“If we said any crates made from X date have to be one- and three-decks, we could start building them now, but we would have to also start being paid/compensated for carting that stock”.

It was generally considered livestock numbers were decreasing, especially with less sheep being transported. It was also considered that generally all livestock have become larger and while the number of sheep have declined, the volume of meat produced has stayed about the same.

“Three-deck trucks for sheep could be an option, as there’s not enough sheep to cart in NZ anymore”.

There were concerns about pressures to lower carbon emissions and having less trucks on the road. When asked if it would help if they didn’t have to drive such long distances and instead animals were processed at nearer works, they said this was all dictated by the meat processors. Many agreed they have been travelling further distances, due to processors needing to operate at full capacity and a lack of workers at the processing plants.

Some operators discussed the benefits of using ‘nearest works’ and toll processing and supported these systems to reduce transport times, however, considered meat companies’ procurement processes and pricing were the main barrier.

“Transport arrangements were better under XXX as calves went to the nearest toll meat processor. There are examples of calves being transported to a premises further away

passing calves coming in the opposite direction which means both loads of calves have longer transport times”.

Another idea was the use of feeder trucks bringing animals to a central point with yards to reduce the travelling around collecting animals from different farms, then having a main unit that transports them to the works from this point.

Some operators thought that in order to meet some of the requirements, *we will cost ourselves out of the market* when trading with other jurisdictions with lower animal welfare standards.

Ventilation

Most transport operators considered there were no issues with the level of ventilation in the current livestock crates; however, contrary to this, some spoke of animal losses due to heat. Some considered that the industry has adapted over the years and most drivers load at appropriate stocking densities on hot days or long distances. They thought appropriate stocking densities should be included in the standards. Some thought sometimes livestock are loaded too tightly.

“You sometimes open the floor up on a hot day and the heat is like a sauna”.

Some operators considered it was challenging for standards to cater for both the North and South Island, due to the differing ranges in ambient temperature. It was considered important that any design changes must not compromise the structural and strength aspects and ease of cleaning, and some thought too many wall openings would cause structural issues. The fact that ventilation requirements were different for different species (e.g., calves vs. dairy cows) was discussed and the challenges catering for multi-species.

“There’s no other country in the world that attempts to transport that many species in a single crate design”.

Some considered that the ventilation gaps could be wider and designed in a way to prevent legs protruding (e.g., a rod), however there were concerns that more rainwater would come through making calves wet, and effluent escaping would be an issue. Others raised concerns about woolly, unshorn sheep blocking vents, which was a farmer issue. Some considered newer designs where the vents are higher compared to old designs are better for providing airflow at head height and preventing legs protruding.

There was strong agreement that if farmers stood animals off pasture as required, this would reduce the ammonia levels and gases produced by urine and faeces and solve many other issues.

When asked about having a continuous ventilation gap along the length of the crate (similar to the old crate designs), and recommended in the NZLTA standards, some supported this idea and others thought there would be structural issues. However, all crate manufacturers considered this was possible and that some new builds had been designed this way recently. Some transport operators preferred the appearance of the oval vents, saying that they ‘looked better’.

Some companies have implemented the ‘concertina’ type floors (on the second and third decks) that fold in such a way that they don’t block the vents when the floor is folded up.

Some operators agreed this floor design would help open up the vent more but weren't in favour of this design since it reduced the space inside the pen by 50mm.

Another comment made was that when centre dividing gates are not used by drivers, they are often hung up on the wall also blocking ventilation gaps within the pen. Drivers not using the centre gates was also considered a risk to animal welfare and was sometimes used as a strategy to push more animals into a pen, especially sheep and lambs.

When asked if colour was considered when building a new crate (with darker colours absorbing more heat), most operators hadn't considered this as a factor to reduce heat load. One operator considered a difference in temperature in areas of their crate that were white vs. a darker colour.

Some suggestions for improvements included:

- vents/ducting system (air scoops) on the front wall of the crate to push air into each deck level below when the truck is moving (similar to the designs experimented with in the old fibreglass crates);
- insert small air vents lower down (e.g., 6 inches off the bottom of the crate wall).
- continuous air gap under the troughs;
- ventilation gaps could be made wider but may require a bar; and
- a continuous vent across the entire length of the crate.

Space

In general, most operators focused on larger cattle not fitting the height of the crate decks and overlooked the fact that this is also an issue for other species.

There was considerable discussion about the differences in heights within species, (e.g., lambs vs. sheep, dairy sheep being bigger), different breeds and the selection for larger animals, therefore taller livestock are being transported. Improvements discussed included new trailer crates being built with a step-down floor on the bottom trailer deck to provide more depth.

Some considered that the recommended deck heights for calves needed changing since, like pigs, *'they lie down anyway'*. Most recognised that the crate design did not allow transporters to meet the space requirements for ewes, however most thought for store stock or lambs, head space was not an issue. There was much discussion around what is meant by a 'normal posture'.

"None of us really meet the requirements for carting ewes. Heads are down so they're not travelling in a natural position".

"Pen density is an issue. We have the right to refuse but there is also industry pressure. We're in the middle and some things are out of our control – the regulator may need to step in".

It was raised that some meat processors are disincentivising farmers sending larger livestock, for example, a 370kg carcass weight cut off for beef, with a price decrease of 20 cents/kg above that weight.

“If an animal is too tall, drivers should be leaving them behind. Works are now penalising farmers if cattle are too big which is helping with this issue”.

There was considerable discussion about increasing the road height limit from 4.3m to 4.5m, with some suggesting this would be better than going back to less decks and that it would solve most of the issues around meeting the standards. Some said they had advocated for this change for many years. However, many operators disagreed this was the solution long term and raised issues such as livestock continuing to grow bigger, low bridges, low power lines, health and safety (i.e., harder to get out of higher pens) and the increased risk of trucks rolling over.

Some operators said they had upgraded their crates recently and had increased the length. However, for operators servicing the East Coast of the North Island, shorter crates are becoming a necessity to accommodate for the roads that are already challenging to access and navigate.

Some suggestions for improvements included:

- increasing the road height limit to 4.5m;
- fit trailers with smaller tyres, which has helped increase deck heights - some issues in mud and wear faster but these are lower and possibly more stable;
- lower chassis trucks;
- single-deck cattle and two-deck sheep – *‘but who will pay?’*; and
- remove walking rails on top and replace with an alternative design to provide strength, to reduce back rub and prevent drivers walking on top.

Covers and Shelter

It was considered that most reputable carriers use covers, and it would usually be a company policy to use them for every load.

“Everyone has them and they are supposed to be used”.

“Once again, its driver education. Its only laziness to not be using them”.

There was considerable discussion about the shelter regulations for calves during transport and the challenges keeping them dry. Everyone agreed this was difficult on a wet day given farm facilities, crate designs as well as some unloading facilities at meat companies and changing weather conditions. There were concerns about the definition of a wet calf and how MPI was enforcing the regulation.

“We need driver education – if they are wet don’t pick them up, but how wet is wet?”

Some suggested the current covers were suitable to protect calves from wet weather, but others acknowledged this is a challenge since the covers are not waterproof. There were also challenges in preventing rain from coming through the side vents. There were concerns about solid covers reducing ventilation and creating a driver safety issue if they can’t get out.

Flooring and Ramps

Most operators considered they were meeting the current standards for flooring.

There was an obvious difference in opinions about the use of grip bars used for flooring between the North and South Island transport operators and drivers, with very few/none using them in the South Island. Some South Island operators questioned whether grip bars were even still permitted. They considered that they were not suitable for sheep (i.e., they end up lying in effluent and can't stand comfortably), and *"it is difficult for cattle to stand on them as they are standing with their feet on an angle because of the bars"*.

Many operators agreed cattle can't stand with their hooves in a flat position and they move around more as they attempt to keep their balance. Those that used grip bars considered the benefits were ease of cleaning and reduced weight, including the weight of the material as well as the ability to lift them up so that the effluent drains off, providing an immediate reduction in weight of the effluent.

Some operators considered the steel mesh on all decks was best practice. Most thought steel mesh for the bottom floor and perforated steel for the other floors was best. However, they considered that the perforated holes are sharp when they are new and then wear down over time (after 5-10 years, some suggested 15 years), therefore eventually lose their grip and become slippery.

One manufacturer considered there were alternative materials for flooring available such as a rubber/anti-fatigue matting, but they don't have the characteristics of aluminium and can't perform the function that is needed (e.g., light weight, easy to clean).

"There will always be trade-offs; light, strong, cheap – you have to pick two from an engineering perspective."

Many operators considered the old plastic flooring, still fitted in some older crates, were slippery and unsuitable. One operator suggested oval perforated holes are easier to clean and effluent drains better compared to the round perforated holes.

When asked why guidelines for external loading ramps state that they should be no steeper than 20 degrees, but internal ramps in crates are steeper and was this an issue during loading and unloading, there was little comment. However, one operator pointed out that cattle often baulk at the bottom of the ramp because the internal ramps are steep, which effects animal flow during loading.

Some suggestions for improvements included:

- farmers and stock yards should have double deck ramps to make it easier to load cattle directly onto and off the top deck; and
- for grip bars - move the rods from 100 to 150mm.

Health and Safety

There was some disparity in opinions about whether health and safety was really a problem within livestock crates, however, some issues identified included:

- working within the crate and injuries caused by animals (e.g., crushing, falling, trampling) -not always a clear escape route;
- lifting heavy ramps and floors;
- working on top of the crate and fear or risk of falling;
- driver inexperience with handling livestock; and
- livestock, especially beef cattle unfamiliar with human handling (e.g., on East Coast, North Island farms).

“We work up there every day and are used to it”.

“It’s not ok to be walking on the top of a 4.3m crate - the risks of falling off are too great”.

Some operators had made it a company policy that all crates have safety rails installed on the top of the crate, however, many reported that not all drivers use them. Others said they are more of a visual deterrent and are not rated, as they would not hold much weight if someone fell. Some drivers were uncomfortable working on top of the crate and others considered it was a necessity for moving livestock. Some companies would prefer if there was a regulation that prohibited drivers to stand on top of the crates and discouraged it, but rules were not always adhered to.

We asked transport operators what they thought of the CrateSafe™ system (Figure 31).





Figure 31. A CrateSafe™ system installed on the top of NZ crate for driver safety when working on top of the crates, also ensuring that covers are utilised as required. Photos provided by Landquip, NZ.

Some companies had installed them on all units to prevent falls and injuries. Benefits identified were two-fold; 1) driver safety and 2) it forces drivers to use covers as per the requirements, since it's not possible to drive without having the covers folded down.

Some operators considered this system wasn't suited to some of the roads and properties they had to access, due to low trees or power lines around loading ramps, and some meat processors having low ceilings preventing their use. Other barriers for uptake included cost and the perception that they added to the height of the crate. But some operators thought these were just excuses.

"If it was regulated, the famer would have to sort power lines etc or the stock wouldn't be picked up".

Some inexperienced drivers were uncomfortable entering crates with beef cattle, reinforcing the need for better animal handling training. One operator said their standard operating procedure stated floors must be lifted up for every load to allow an escape route. One operator said *"as the decks are getting deeper it is getting more difficult for shorter drivers to get out which is why they like walking on the top where it is safer"*.

"If there's a problem inside the crate there's no real escape route – need a step so you can get out of the way".

"If you can't get out of the stock crate, don't get in".

Some newer crates have been designed with a wider boot pen (the rear left-hand pen), which makes the ramp lighter to lift because its narrower. Some had installed spring/winch operated floors and ramps to make them lighter to lift, especially for older drivers.

Some designs also now have an external door at the second cattle deck height at the rear of the crate, enabling the driver to enter the crate at a lower height rather than climbing up and over the top of the crate.

Air operated gates and doors, which can be operated from outside of the crate, were discussed. There were differing views, with some suggesting they are good for unloading but less helpful during loading. A number of operators had implemented air/remote operated gates. Some thought there were a few improvements that could be made and systems that prevent the need for being on top were preferred.

“Remote gates are a good idea, but there are always going to be times you have to get in or on top to move animals around”.

Some operators were not interested in anything that involved more moving parts and technology as it was just more things that can break down and more maintenance, preferring manually operated parts. Lights inside crates were considered a big improvement and were considered a standard design now for new builds.

Some other improvements considered included doors that open from both sides, with double doors that open together being safer as it creates a protected space for the driver. Three-quarter doors that open in a way that they can create a protected space for the driver were also considered to work well for driver safety. Many operators and drivers considered standing behind the gate pulled back with your boot to hold the door open was a common strategy to prevent being crushed, but that this doesn't always work. Some companies had put slots on the solid doors so the driver can climb up out of way easily.

“If the top floor is down, there is nowhere to go if you are unloading stock off the bottom deck”.

During discussions about covers, driver safety was mentioned.

“With some covers, you can't take them off from the top and have to crawl into the deck – possibilities to make them better...”

“Drivers have to use them-you have to lift them to unload, but if it you can't lift them its unsafe”.

Some suggestions for improvements included:

- adding steps within crate pens and/or foot holes on the gates;
- air operated doors and gates or other remote systems that allow loading/unloading from outside the crate;
- use of carbon fibre material to reduce weight;
- changing the latch locations for driver comfort and safety;
- driver training/education; and
- doors within the crates that open and fold together to protect the person working within the crate.

Issues raised related to the wider supply chain that impact on animal welfare and transport operations

1. Farmers not preparing animals or standing them off pasture as required was one of the most frequently raised issue.

“Managing the bobby calf situation has proved that if farmers did their part, then transport is OK – good facilities, right animal, and prepped properly. If the same was done with all other classes of stock — dehorned, emptied out, shorn, healthy, problems would be solved”.

2. Lack of sufficient facilities at farms and saleyards (loading ramps, yards, bobby calf shelters) and no one inspecting them.

“Sale yards often have no shelter, no water, standing on hot surfaces (concrete) and animals are heat stressed when you load them”.

3. There needs to be a requirement that all ramps and loading facilities meet a certain standard at all locations.

“Saleyards need more monitoring... no one seems to regulate the saleyards for anything in NZ”.

4. A lot of farmers still not aware of the Fit for Transport App.
5. Drivers having to continuously be educating farmers (e.g., what is fit for transport, NAIT requirements) for issues they become accountable for.

“Transporters have to police regulations”.

Note: this aligns with findings from a survey of Atlantic Canadian transporters that reported they felt unfairly responsible for teaching farmers about cow fitness for transport, highlighting the need for better training of farmers on livestock fitness for transport and education on the transport regulations (Hendricks et al. 2023).

6. Animals are becoming bigger through breeding/genetic selection.
7. Farmers/stock agents not selecting and drafting animals properly into groups for height.

“There’s a need for loading facilities where animals can be sorted by height and loaded appropriately”.

8. Need for stock agent education.

“They need to be aware of the chain of responsibility. Often they don’t see the animals” (online systems and short notification times).

9. Stock agents not checking bobby calf shelters are up to standard.

“Calf loading facilities should be checked when the agent visits to hand out the tags and get the ASD signed”.

10. Pressure from stock agents to overload stock. Information about animals from stock agents not being sufficiently communicated such as heights, numbers, breeds, sheep being woolly and other factors that make a difference to loading procedures.

“The nature of the stock also affects loading/unloading, for example quiet, passive dairy cows vs. wild beef cattle, especially on the East Coast (North Island)”.

11. No one on site to assist when animals are loaded and unloaded (farmers, stock agents and at the works). This is also, a health and safety issue, for example if the driver is injured during loading. Also, during unloading at the works animals can turn around and come back, which could be prevented by extra handlers.

"Works often draft cattle as they come off and this slows unloading– it's better to get all animals off quickly. Some premises have islands for NAIT tag reading in the unloading race and this also impedes stock flow".

"They don't think someone needs to be onsite when loading stock... needs to be more support for the carriers. They make the sale and then that's the end of you seeing them".

"There are a few good farmers that want to be there during loading and want to ensure it's done properly ... the driver is meat in middle of sandwich if there is an issue".

12. Double deck ramps should be required for all dairy farms (new builds) and saleyards.
13. Long waiting times stationary at the meat processing plants – some reported up to 3 or 4 hours and more.
14. Driver breaks/hours and electronic logbooks/new requirements. Stationary periods on hot days pose a risk to animal welfare.
15. Meat processors need to open truck wash facilities and issues managing effluent.
16. Not enough places to empty effluent across the country.
17. Need for driver education. Lack of experienced drivers with stock handling skills.
18. Lack of drivers or incentives to drive livestock trucks and an ageing workforce.

"Hard to keep drivers that are getting infringements that should be on the farmer (e.g., NAIT, cancer eye etc) - why would they want to cart livestock?"

19. Appropriate fines/penalties are needed for farmers vs. drivers, especially for health issues that can be easily missed by a driver standing on one side during loading (especially in the dark) that the farmer is likely aware of (e.g. cancer eye, udder health).

"Farmers should get notifications when drivers are fined and they need to be made more accountable".

"Farmers should be fined for not standing animals off or presenting tall stock".

"It's unfair given the farmers see them for four days and the transporter sees them for four minutes. Needs to be a weighted fine system e.g. \$800 to farmers and \$200 to transporters. This should be across species and not just bobby calves".

“A more even playing field is needed...we are not meeting the standards...we need more specific regulations so everyone (i.e., meat processors, farmers, stock agents) is on same page...it needs to be that everyone knows what the standards are and everyone needs to comply (e.g., restrictions for how many and how they are carted), and transporters are paid to cover the costs”.

“Deer transport is generally ok, as they set the standards across the chain early on”.

Accreditation system

There was general agreement from all stakeholders we engaged with that the audit process carried out by AsureQuality was insufficient and that it was a ‘box ticking, revenue collecting exercise that is meaningless in terms of meeting standards and animal welfare’. There were concerns these audits are carried out by inexperienced people that didn’t know what to look for and they were not required to audit against all standards.

“When you get a crate certified, you assume that means it’s ok”.

“AQ put a QR sticker on the crate, mostly inspected, but not always. Gives the impression the crate is ok and meets standards”.

“Auditing is not meeting the standards and not meeting the needs of the system assurance that are required”.

“The audit should include an inspection of the loading race at same time”.

There were concerns that the certification did not apply to all livestock crates. Some crates are on-sold to small owner/operators or farmers wanting to cart their own animals and these crates are not subject to the accreditation programme.

“You’ll see tandem trailers at saleyards with no ventilation and are not up to standard”.

“Meat processors accept animals coming off second hand, uncertified crates; again it’s not an even playing field for those trying to comply with standards”.

Audits were considered to have nothing to do with ensuring animal welfare standards or health and safety of drivers.

“When the audits are done there is little looked at in terms of animal welfare or health and safety”.

Proposed next steps:

- A ‘social contract’ between farmers, transport operators, stock agents and meat processors would ensure all parties responsible for making decisions that impact on animal welfare have shared expectations and would help create a level playing field across the supply chain using a One Welfare approach.

9. Health and Safety

Health and safety requirements and considerations have a significant impact on crate design and the transport process, with flow on effects for animal welfare.

From data provided by the Accident Compensation Corporation (ACC), the number of claims related to livestock trucks, between January 2021 and 31 December 2022, mostly involved livestock (cattle and sheep, Table 5) and crate doors/gates, and were largely due to lifting, carrying/strains and loss of balance (Table 6). The number of claims has reduced slightly in recent years (Table 7).

However, there appears to be a high acceptance of risk amongst NZ transport operators and a low level of reporting, therefore, it seems likely that these figures underestimate the issues.

Table 5. Number of ACC claims (top ten) for livestock truck related injuries by external circumstance, between 1 January 2012 and 31 December 2022.

	Lodgement Calendar Year										
External Circumstance	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Live Cattle	95	90	83	110	79	70	62	63	66	57	53
Live Sheep	31	29	26	29	39	44	22	13	23	15	26
Door / Gate / Lid	16	18	14	13	13	12	16	19	11	12	12
Ground / Path	11	23	16	19	14	11	12	11	8	12	13
Box / Carton / Crate	13	9	9	12	11	7	11	19	7	9	12
Vehicle - Truck	16	6	13	9	13	10	7	3	5	6	3
Fence / Railing Wall	8	4	5	11	3	7	8	8	6	9	4
Other Live Animal	4	3	16	7	8	9	4	3	1	1	
Floor	3	1	4	4	2	5	3	2	6	2	4
Sharp Object	2	4	6	4	3	2	6	1	1	2	3
Other / Unknown	32	41	47	49	46	51	59	50	41	56	46

Table 6. Number of ACC claims (top ten) for livestock truck related injuries by cause, between 1 January 2012 and 31 December 2022.

	Lodgement Calendar Year										
Cause	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Struck by Person / Animal	81	63	60	90	59	71	53	35	35	29	35
Lifting / Carrying / Strain	29	31	31	36	52	23	28	22	18	24	21
Loss Balance / Personal Control	16	17	33	27	23	25	25	35	40	30	28
Work Property or Characteristics	32	25	48	35	37	38	19	17	17	18	6
Collision / Knocked Over by Object	19	18	14	8	16	11	12	29	21	20	20
Object Coming Loose / Shifting	12	14	16	13	9	9	15	13	6	10	7
Slipping / Skidding on Foot	12	13	12	21	10	7	15	7	9	6	12
Puncture	4	10	7	8	3	12	18	11	9	14	14
Twisting Movement	9	4	4	8	6	10	7	13	7	14	11
Pushed / Pulled	3	7	4	10	10	7	5	7	7	12	10
Other / Unknown	14	26	10	11	6	15	13	3	6	4	12

Table 7. Number of new and active ACC claims for livestock truck related injuries between 1 January 2012 and 31 December 2022.

Calendar Year	New Claims	Active Claims
2012	231	301
2013	228	274
2014	239	305
2015	267	341
2016	231	326
2017	228	301
2018	210	303
2019	192	279
2020	175	260
2021	181	257
2022	176	242
Total	2,358	2,282

A number of factors affect health and safety. Issues raised during the workshops are discussed in the section above. Some of the issues included the ageing workforce, fitness for work (e.g., dealing with old injuries), a lack of younger drivers interested in transporting livestock. Some of the younger drivers considered that you needed to have an interest in livestock and farming as it's easier and less stressful to drive freight trucks, with better pay and no requirements/pressure to meet animal welfare regulations.

Some expressed concerns about the lack of experience younger drivers have with handling livestock. They are coming into the industry without any practical animal handling training and basic knowledge of livestock behaviour. Working in such close proximity to unpredictable animals in stressful situations is a significant risk to both animal welfare and human safety.

There are significant health and safety risks related to livestock transport including risk of injuries, falling from heights (Figure 32), being crushed by livestock when working in tight spaces, fatigue and stress (e.g., long hours and pressures to meet tight schedules dictated by stock agents and meat processors). As discussed above, the CrateSafe™ system provides a safeguard against the risk of falls when drivers are working on top of the crate as well as ensuring covers are used.

Drivers are often faced with increased risk when handling extensively raised cattle that have had minimal human contact and may respond unpredictably and/or aggressively in response to the stress of loading/unloading. In these circumstances, there is often no easily accessible escape route and drivers can be cornered by the animal or trapped/crushed behind a gate.



Figure 32. Driver moving livestock from the top of the crate poses significant health and safety risks (left). The CrateSafe™ system (right).

Some operators we engaged with had incorporated internal steps to assist with exiting from the pens. Fitting features such as ladders, steps or handholds would help reduce risk to driver safety, however at the same time, they need to be designed to minimise any risks of rubbing or injuries to livestock.

Following a driver sustaining a fatal injury while loading cattle in Queensland, Workplace Health and Safety Queensland (WHSQ) undertook a review (WHSQ Project report, 2017) and developed health and safety guidelines²⁴. The WHSQ guidelines recommended drivers stay out of the crate as much as possible. However, this is not considered practical by most operators as often the driver needs to be in the pen to move livestock, especially during unloading.

The guidelines suggest a blocking or safety gate could be used to prevent livestock turning and coming back to the driver, or an internal gate designed as an area for the driver to stand behind the door to maintain a physical barrier between the driver and the livestock. Some operators we engaged with considered such a design feature would be a good solution.

Many operators raised concerns about poorly designed or badly maintained loading ramps at farms and saleyards, which can lead to livestock injuries and driver falls and slips. For example, gaps between loading ramps and crate doors, steep ramps, sharp edges, protruding objects and insufficient construction, which would unlikely meet the minimum standards in the transport code of welfare. The industry is currently developing guidelines for livestock loading facilities.

Drivers are often working alone in remote areas and/or at nighttime with insufficient or no lighting and are often required to work in adverse weather conditions. Although it appears that all new livestock crates are fitted with internal lights, there are many old crates still in operation without lighting, which poses a risk to driver safety and animal welfare (e.g., falls, slips, baulking at dark spaces during loading/unloading). Some drivers we engaged with said this can present additional challenges in identifying animals that are not fit for transport, which is difficult enough when there is lighting or during daylight hours.

²⁴ [Guide for safe design and use of cattle crates \(worksafe.qld.gov.au\)](https://www.worksafe.qld.gov.au/guide-for-safe-design-and-use-of-cattle-crates)

Driver breaks are important to reduce fatigue, but current rules pose a risk to animal welfare. In any cumulative workday (legally defined as no more than 24 hours), drivers can work a maximum of 13 hours and must then take a break of at least 10 hours (as well as the standard half-hour breaks required every 5½ hours)²⁵. Many drivers considered the rules were impractical, due to the nature of their work schedules and recognised the risk of heat stress for livestock when they are required to stop on the side of the road to take a 30-minute break on a hot day.

Some transport operators are trialling a system (The AlertMeter®)²⁶ to identify when a driver is at risk of fatigue. It remotely predicts at-risk drivers by tracking compromised alertness against an individual's baseline in real time. This technology has the potential to be used more widely across the industry with the hope that driver break requirements could be made more flexible and taken when needed, without compromising driver safety and animal welfare. There could be other benefits such as increased productivity, improving the workplace safety culture and providing a better work/life balance for drivers²⁷.

As discussed above, transport operators and crate manufacturers identified a range of improvements and new innovations to reduce driver health and safety risks such as remotely operated pneumatic and hydraulic gates, winch systems for moving internal ramps (Figure 33) and lighting. Although some operators had requested these design changes for new crates and retrofitted some older crates to improve driver safety, others considered that they were too expensive.

In the WHSQ Report (2017), it considered that advancement in technology (i.e., in function, materials, and robustness) and the reduced costs has made incorporating these features more feasible, while acknowledging incorporation of safety innovations is more feasible at the design stage for new crates compared with retrofitting older crates.



Figure 33. Winch operated ramp to mechanically lift/move the internal ramp and reduce the risk of injuries.

²⁵ [Work time and logbooks | Waka Kotahi NZ Transport Agency \(nzta.govt.nz\)](https://www.nzta.govt.nz/work-time-and-logbooks/)

²⁶ [AlertMeter® Alertness and Ready-to-Work Software \(predictivesafety.com\)](https://predictivesafety.com/alertmeter/)

²⁷ [Yellow Black Cities Monthly Report \(predictivesafety.com\)](https://predictivesafety.com/yellow-black-cities-monthly-report/)

Despite the important role drivers have in livestock welfare, very little is known about the perceptions, attitudes and knowledge drivers have of the different livestock species they interact with daily and their different behavioural needs.

This project has only touched very lightly on the driver health and safety risks and issues associated with livestock crates in NZ. There is a need for further research to investigate the extent of the issues and the impacts on driver well-being and animal welfare that are outside of the scope of this project. This includes job satisfaction, work pressures, stress and fatigue, and attitudes towards animal welfare, which all ultimately have an impact on the welfare of the animals they work with (Pastrana-Camacho et al., 2023).

Such research should use a One Welfare approach (Figure 34), which recognises the interconnections between animal welfare, human well-being and the environment (García Pinillos et al., 2016). This could initially be a survey to gain insights into driver's opinions and experiences, and knowledge about animal livestock behaviour and husbandry, with a focus on animal welfare and human well-being.

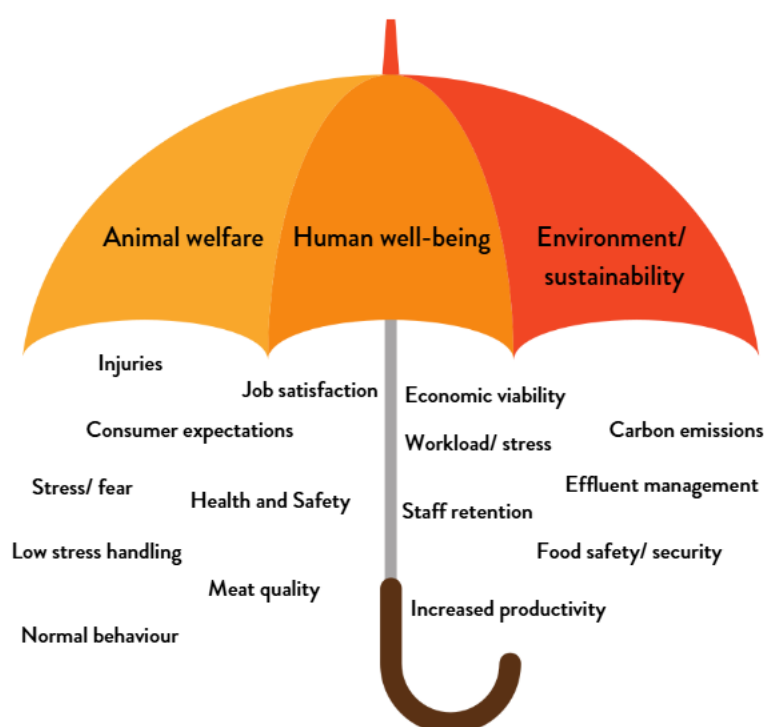


Figure 34. A draft concept for a One Welfare approach for livestock transport showing the overlapping, interconnections between animal welfare, human well-being and the environment. Modified from (García Pinillos et al., 2016).

This is a significant and important gap in knowledge and such research is needed to develop driver training strategies, improve livestock welfare, and promote the importance of drivers' role in animal welfare, while providing opportunities to increase job satisfaction. A basic understanding of livestock behaviour and low stress handling techniques would help improve efficiency of loading and unloading, animal welfare and driver safety. Improved education resources could go some way towards encouraging more people into the industry, improve staff retention and address driver shortages.

The safety culture and level of acceptance of risk within the industry needs to be addressed through improved education and will need to start at a leadership level. From the evidence shown here, WorkSafe and the industry need to do more to improve the situation for drivers in NZ and should work together to develop guidelines similar to those used in Queensland.

Proposed next steps:

- A One Welfare research study should be undertaken with a focus on animal welfare and driver well-being. Findings could be used to build on education programmes to improve driver knowledge of livestock behaviour and low stress handling techniques. This could go some way towards encouraging more people into the industry, improve staff retention and address driver shortages.
- To improve driver safety, new crate design features that focus on providing protection for drivers working within crates and reducing the need to work on top of the crate should continue to be developed.
- It could be beneficial for driver health and safety if guidelines similar to those implemented in Queensland, Australia, are developed and implemented in NZ.

10. Summary and conclusions

The key features of NZ livestock crate design that impact on animal welfare during transport include ventilation, space allowances, ramps, flooring and shelter. NZ livestock crates have multiple deck configurations with deck heights designed to accommodate multiple species of different ages; however, the different livestock species being transported have different behavioural and physiological needs. Therefore, this 'one size fits all', multi-purpose design may fail to meet species-specific needs.

Since deaths, injuries and other harms caused to livestock as part of the transport process continue to occur, this suggests that further improvement is needed. However, there has been little or no scientific evaluation of the current crate usage and designs, including more recent modifications, and their effect on the crate environment and animal welfare. Furthermore, both government and industry standards are out of step with current science and current crate design and use.

One of the issues identified was inadequate ventilation and head space to allow sufficient airflow and meet the requirements for animals to adopt 'normal' postures. Therefore, the current design appears to be ineffective for managing heat stress in livestock and if future livestock crates in NZ remain reliant on passive ventilation, changes will be required to improve airflow and space allowances.

Steep internal ramps, some flooring surfaces, and the inability for covers to protect animals from weather extremes also make it difficult to meet current standards. Advancements in technology for improved flooring surfaces and covers for shade and shelter, and the design of exit/entry points will need to be considered to improve animal welfare and driver safety.

The new livestock crates on NZ roads in 2023 are a result of pushing the current crate design to its limits and making small incremental changes to the design (e.g., drop down floors in an attempt to increase the bottom deck height). These changes appear to have been mainly driven by the need to reduce transport costs and comply with the 2018 Animal Welfare (Care and Procedures) Regulations, such as back rub, to avoid infringements. The aesthetic appearance of the crate is also a consideration. It is unlikely that continuing to invest in these small incremental changes, within the limits of the current crate design, will provide the required improvements for animal welfare or driver safety.

There were varied opinions between transport operators. Some considered the incremental changes to livestock crate designs made over recent years have improved animal welfare and the current design is fit for purpose, with no further changes required. However, it was acknowledged by some transport operators that the crate design is not fit for all purposes, making it difficult to meet some animal welfare standards, such as ventilation and space requirements.

Changes to crate design features often require trade-offs between animal welfare and weight, strength, cost and meeting other requirements. Other trade-offs for animal welfare are driven by the demand to meet operational needs and procurements schedules (e.g., capacity at meat processing plants and sale yards, journey distances, overloading animals, waiting times).

Many of the issues regarding specific crate design features could be resolved by going back to species-specific crates or reducing the number of decks. Some transport operators

considered reducing the number of decks as an option to help meet current welfare standards. However, a common theme was the concern regarding the increased cost of transport if such changes were required, and where this cost should fall. Many transport operators reported that the industry operates on extremely tight margins, and for a significant portion of their work, meat companies dictate the cartage prices.

Although previous applications to the NZ Transport Agency have been declined, some transport operators considered continuing to lobby for a change in road rules to increase the height limit from 4.3m to 4.5m could solve a lot of the issues with meeting current animal welfare standards. However, others disagreed this could provide a sustainable solution and raised issues such as livestock continuing to grow taller, low overhead bridges and power lines, health and safety and the increased risk of trucks rolling over.

Some transport operators expressed concerns that by reducing the number of decks on livestock crates, more trucks and drivers would be needed on the road, which would increase issues around carbon emissions. Reducing transport distances by way of toll processing/'nearest works' where livestock are transported to the nearest processing plant would go some way in reducing carbon emissions. This would also have implications for improving livestock welfare (e.g., shorter journeys) and driver health and safety (e.g., fatigue).

Transport operators generally held the view that given a livestock crate has a 20-year life, a 20-year transition period would be needed for any changes required. In the case of any changes being enforced, a thorough cost/benefit analysis and risk assessment would be essential. Incorporation of new features and innovations is more feasible at the design stage for new crates compared to retrofitting older models.

Overall, this research supports the case for reviewing and updating current livestock crate guidelines and related industry and government standards. All crate manufacturers and transport operators we engaged with considered the NZS 5413 standard to be so outdated that the crate designs have long since superseded this standard. The literature review and information from stakeholder engagement presented in this report provide information to inform an update of the standards.

It is recognised that further scientific research is required to inform the development of comprehensive crate design standards. For example, studies investigating the impact of varying wall opening dimensions and optimal head space are needed. Although there is some agreement overseas regarding appropriate head space allowances, evidence-based thresholds for species-specific head space requirements remain a knowledge gap that needs to be addressed. There is also a gap in the literature regarding prevention of cold stress in winter, especially in young animals that are more vulnerable.

It should be noted that transport operators face the challenge of complying with numerous regulations from various agencies concerning animal welfare, health and safety, and environmental requirements. There is also a shortage of qualified livestock drivers and significant challenges trying to attract new people into livestock driver roles. These aspects add further challenges to creating a platform that allows for change to evolve.

Other risk factors to consider

Due to the low livestock crate turnover (crates are retained for 20+ years), there are likely many crates still in use that pose a high risk to animal welfare. Some crates are on-sold to smaller transport operators or farmers to transport their own animals and can stay in operation for many years. These privately owned livestock crates are not subject to the accreditation programme and therefore may pose a risk to animal welfare and driver safety.

Many transport operators expressed concerns with the current accreditation system, including the lack of experience of some auditors, lack of animal welfare considerations and that it does not apply to all crates transporting livestock on NZ roads. The overwhelming feedback from transport operators was that they considered the system needs to be reviewed.

A range of issues relating to transport more broadly, were raised during the stakeholder engagement component of this research. It was expressed that there is some ambiguity and a lack of clarity across some of the transport related industry and government standards (e.g., what do the requirements normal posture or adequate ventilation mean). This creates confusion about what is required and limits the ability to create a uniform minimum level of requirements across the supply chain to safeguard animal welfare.

There appears to be various views regarding whether or not health and safety is an issue within the sector, and a high acceptance of risk (i.e., 'it's the way it's always been done') among some transport operators. However, significant risks to driver safety were identified including risk of injury, falling from heights, being crushed by livestock when working in tight spaces, fatigue and stress (e.g., long hours and pressures to meet tight schedules).

There appeared to be varying attitudes among drivers regarding livestock and animal welfare, with a common perception that many younger drivers lack experience in basic livestock handling. While this research was primarily focussed on livestock crate design, it is important to acknowledge the direct impact the role of drivers has on animal welfare. Providing livestock handling education for drivers could improve both job satisfaction and driver well-being, as well as animal welfare.

It would be remiss not to include this feedback and other issues raised during stakeholder engagement that could be considered out of scope of the research but has implications for animal welfare.

Operational issues

It is clear there are wider issues associated with the procurement process and supply chain that pose risks to animal welfare, driver safety and sustainability of the industry that cannot be eliminated through improved crate design alone. While these issues are outside the scope of this project, a strategic approach is needed to address them at a whole-of-system level, using a One Welfare approach.

Areas in need of improvement include, but are not limited to:

- reducing waiting times at processing plants;
- improving driver safety and fatigue strategies;

- reducing journey distances, with more consideration for nearest works/toll processing;
- animal welfare included in livestock crate accreditation programmes;
- improved loading facilities; and
- better communication between all parties along the supply chain.

Transport operators are highly reliant on good communication and cooperation of all parties across the supply chain, which has a significant impact on animal welfare and driver health and safety. Therefore, all parts of the supply chain need to take responsibility for animal welfare and driver well-being, and support transport operators to reduce the risks to themselves and livestock welfare during transport.

It was suggested that a stronger sense of collective accountability across the supply chain was needed to meet welfare standards and regulations during transport. A 'social contract' between farmers, transport operators, stock agents and meat processors were deemed necessary. This would ensure all parties responsible for making decisions impacting on animal welfare have shared expectations and help create a level playing field across the supply chain.

Regardless of whether changes are proposed by regulators or not, the industry could better position themselves by taking a proactive approach, including reviewing and improving industry welfare standards and developing scientific-based crate design requirements. The DeerQA Programme is a good example of proactive, industry-led change and improvement, where all stakeholders in the deer transport, farming and processing sectors took a collaborative approach to establish and agree upon practical, science-based standards and procedures that included animal welfare and health and safety.

An opportunity exists for the livestock transport industry to lead change and development, as opposed to having it brought upon them by the regulator. Standards will need to be incorporated into a robust assurance programme to protect livestock welfare, meet consumer expectations and assure government that requirements are being met through demonstrated compliance with the transport code of welfare and associated regulations.

Given predictions that extreme weather events will increase with climate change, the risks of heat and cold stress in livestock during transport are likely to increase. Therefore, it would be in the best interests of the industry that crate design changes go beyond minimum standards to future proof the design of livestock crates. Additionally, there are other standards that are out of step with current science, for example, requirements for transporting livestock on interisland ferries and outdated stocking density guidelines (e.g., NZLTA).

As a final word, this research is only one part of a larger puzzle, with crate design only part of the equation. A One Welfare approach is required for meaningful improvements to be made for animal welfare and driver safety, as well as meeting expectations around carbon emissions and environmental requirements. System level changes across the entire supply chain are required to ensure the sustainability of the transport industry in NZ.

This research marks the initial phase in gathering essential information to guide long-term initiatives for improving animal welfare during transport in NZ. These efforts will require

collaborative action from a wide range of stakeholders including the NZ Transport Agency Waka Kotahi, NLTSG, WorkSafe and all participants across the supply chain. Initiatives need to include further scientific research to inform industry and government standards, guidelines and regulations that would form part of a long-term programme of work.

11. Proposed next steps

Review and update the suite of standards that influence livestock crate design and impact on animal welfare during transport

1. Industry and government guidelines and standards will need to be reviewed and updated to reflect current scientific knowledge and an understanding of the different needs for each livestock species being transported in NZ.
2. During the standards review process, clarification of what is meant by 'normal/natural postures' and specific measurement points of the animal should be included, e.g., the highest point of the back or the head, and the head room required between the head and the ceiling.
3. To ensure consistency with industry recommendations for external loading ramps, internal ramps should not exceed a slope of 20 degrees for cattle and the more gradual inclines recommended for other species, with appropriate rise and tread dimensions.
4. A minimum standard for lighting systems in livestock crates should be established to ensure drivers have sufficient lighting to safely load and unload livestock and undertake the required inspections of livestock during the journey.
5. To improve animal welfare, comfort and the ability to maintain balance, the use of grip bars on flooring should be reviewed.
6. Initiatives to increase driver compliance with industry requirements for the use of livestock crate covers should be developed.
7. The livestock crate accreditation system should be reviewed, with an improved focus on animal welfare. Additionally, all livestock crates on NZ roads should be subject to the accreditation programme, not only those that are part of the NZLTA programme. This could be an expectation and requirement set by meat companies.
8. To help monitor conditions inside the crates, data loggers could be installed in livestock crates to measure THI so that, where possible, preventative action can be taken to mitigate thermal stress during transport and stationary periods.

Research is needed to inform the standards review and future livestock crate designs

9. The following scientific research, based on an understanding of the different needs of each species, will help inform the standards review and future improvements to NZ livestock crate designs:

- a. assess the impact of head space on livestock behaviour and environmental conditions within livestock crates to ensure optimal ventilation and allow normal standing postures;
 - b. determine optimal positioning and dimensions of wall openings to ensure sufficient airflow and quality within crates and develop designs/construction materials that allow larger openings while containing effluent;
 - c. develop new technologies to help maintain appropriate environmental conditions within all pens and deck levels during transit and stationary periods;
 - d. investigate the risk of cold stress in different species being transported across different regions;
 - e. develop new technologies and materials for covers that provide appropriate shade and shelter;
 - f. develop designs or systems to prevent rain and cold entering crates to prevent cold stress, which could include covers/shutters that provide both sufficient shelter and ventilation;
 - g. determine optimal stocking densities to provide more relevant and useful guidelines regarding the impact on ventilation, air flow and air quality than the current density limits, which were developed using mathematical equations based on animal weight and height;
 - h. develop new technologies and different construction materials to improve the design of floors, ramps and door/gate openings, for improved animal comfort and ease of movement;
10. A One Welfare research study should be undertaken with a focus on animal welfare and driver well-being. Findings could be used to build on education programmes to improve driver knowledge of livestock behaviour and low stress handling techniques. This could go some way towards encouraging more people into the industry, improve staff retention and address driver shortages.

Other proposed next steps

- 11. To improve driver safety, new crate design features that focus on providing protection for drivers working within crates and reducing the need to work on top of the crate should continue to be developed.
- 12. Farmer education programmes should be developed to improve awareness and compliance with the requirements for appropriate preparation of livestock prior to transport, including information regarding time off pasture.
- 13. It could be beneficial for driver health and safety if guidelines similar to those implemented in Queensland, Australia, are developed and implemented in NZ.
- 14. The installation of multi-deck loading ramps at all facilities, including meat processors, saleyards and farms, would help facilitate direct loading onto the upper decks. Loading facilities at saleyards, farms and processing plants could be improved with regular maintenance and standards better enforced through assurance programmes.

15. Ferry companies should work with transport operators, meat companies and other relevant parties to develop an interisland livestock transport policy. This would ensure livestock are not exposed to any unnecessary risk of heat stress and vehicles are appropriately managed and positioned on the wharf and the ferry. This could include heat stress mitigation strategies and contingency plans.
16. A 'social contract' between farmers, transport operators, stock agents and meat processors would ensure all parties responsible for making decisions that impact on animal welfare have shared expectations and would help create a level playing field across the supply chain using a One Welfare approach.
17. Due to the complexity and challenges associated with these issues, and to ensure collective action is taken, it is suggested a formalised action group could be established. This group would be responsible for developing and implementing a tangible work programme, which could be delivered over the next three to five years or an appropriate timeframe determined by industry. The programme plan could include prioritisation and progress of the recommended research initiatives, and revision and development of the standards and policies to improve alignment across the livestock transport supply chain.

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