

Design criteria for cleanability, worker safety and welfare characteristics of pig transport trailers

B. Predicala^{1,2}, A. Alvarado^{1,2}, J. Domingo¹, A. Guevarra¹ and J. Brown¹



Bernardo Predicala



Alvin Alvarado

SUMMARY

Disease transmission associated with transportation of pigs has been a long-standing issue affecting biosecurity in pig production. In addition, stress responses and welfare are greatly influenced by the trailer compartment configuration. The overall goal of this study was to develop a trailer design criteria checklist to provide the industry with an assessment tool to improve the ease of cleaning and the welfare characteristics of pig transport trailers, thereby improving the biosecurity and welfare of animals during transport. This study included a comprehensive literature review and a survey among truckers, wash bay operators and other stakeholders to develop design criteria tailored to swine transport trailers. Those design criteria were used to develop a trailer inspection checklist, made available in an app, that was field-tested on 10 different trailers, and refined throughout all trailer inspections. The checklist was re-structured so that inspections are performed by compartments (i.e., front, middle, and back) and locations in the trailer (i.e., exterior and interior). A rating scale was developed for cleanability, safety and welfare characteristics. An overall score is determined at the end of the inspection to provide a rating on each specific aspect of the trailer (i.e., cleanability, welfare, and safety). It is anticipated that wide-spread application of the inspection checklist across multiple trailers of varying types and conditions will lead to establishment of a rating database that will allow differentiation of trailers according to ease of cleaning and welfare characteristics, and consequently guide the design process to address inherent problems with biosecurity and welfare for building future trailers.

INTRODUCTION

The North American swine industry relies heavily on the transport of pigs. Disease transmission associated with transportation of pigs has been a long-standing issue affecting biosecurity in pig production. Animal transport trailers that are poorly designed in terms of

cleanability are difficult to sanitize and cause significant downtime, increased costs and inconsistent cleaning results, thereby posing high biosecurity risk. In addition, recent studies on evaluation of the impact of trailer design on animal losses and welfare have found that stress responses and welfare are greatly influenced by the trailer compartment configuration. The overall goal of this study was to develop a trailer design criteria checklist to provide the industry with an assessment tool to improve the ease of cleaning and the welfare characteristics of pig transport trailers, thereby improving the biosecurity and welfare of animals during transport.

EXPERIMENTAL PROCEDURES

A comprehensive literature review was carried out to gather available information on key design components or criteria for assessing cleanability, worker safety, and animal welfare that have been developed in other similar industries. These were supplemented through surveys and interviews of various stakeholders such as truckers, wash bay operators, trailer manufacturers, veterinarians, pig producers, and other experts to develop design criteria tailored to swine transport trailers. The design criteria included things like floor plan and ramp designs, surface finish or roughness and protrusions, drainability, welding, sensors and dataloggers, and others. The design criteria were used to develop the initial draft of a trailer inspection checklist, which was made available in an app for easier use by end users. The developed checklist was then field-tested and validated by applying it on 10 different trailers in use in the Canadian swine industry, including potbelly, gooseneck straight deck, hydraulic lift, and straight deck trailers. Different components of the design criteria provided in the checklist were re-assessed and refined throughout all trailer inspections.

RESULTS AND DISCUSSION

The initial draft of a trailer inspection checklist was broken down into three categories: hygiene and cleanability (Table 1), safety (Table 2), and animal health and welfare (Table 3). Each category included recommended guidelines, with a detailed description of each guideline presented as a glossary. In addition, an electronic version of the checklist (in the form of an app) has been developed to provide end users with a more accessible interface (e.g., smartphones, tablets, laptops) for field use. The app can also provide a concise data report for easier review and interpretation, as well as to facilitate compilation of the entire dataset from inspections of multiple trailers. Different components of the design criteria provided in the checklist were re-assessed and refined throughout all trailer inspections. The checklist has gone through seven iterations and was re-structured so that inspections are performed by compartments (i.e., front, middle, and back) and locations in the

¹ Prairie Swine Centre Inc, PO Box 21057, 2105 – 8th Street East, Saskatoon, SK S7H 5N9

² Department of Chemical and Biological Engineering, College of Engineering, University of Saskatchewan, 57 Campus Drive, Saskatoon, SK S7N 5A9

trailer (i.e., exterior and interior), resulting in a more user-friendly checklist that can be implemented more efficiently. To enhance its overall applicability in the industry, a rating scale was developed for cleanability, safety and welfare characteristics. Each component of the design criteria can be rated as Pass, Marginal, Unacceptable, or Replace, with equivalent score of 1, 0.50, 0.25, and 0, respectively. A description of each rating scale was provided in the app to maintain consistency among multiple checklist users. An overall score is determined at the end of the inspection to provide a rating on each specific aspect of the trailer (i.e., cleanability, welfare, and safety) from 0 to 10, with 10 being the highest score.

IMPLICATIONS

It is anticipated that wide-spread application of the inspection checklist across multiple trailers of varying types and conditions will lead to establishment of a rating database that will allow differentiation of trailers according to ease of cleaning and welfare characteristics, and consequently guide the design process to address inherent problems with biosecurity and welfare for building future trailers.

ACKNOWLEDGEMENTS

Funding for this project is provided by Swine Innovation Porc through the Canadian Agricultural Partnership. The authors would also like to acknowledge the strategic program funding provided by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council and the Saskatchewan Agriculture Development Fund.

Table 1. An overview of the different components included in the trailer checklist for cleanability

Key Area	Description
C1.Surface Finish and Material of Construction	1) Interior surface materials can withstand 2,000 – 2,800 psi water pressure and heavy-duty chemical disinfectants repeatedly without being damaged. Materials used are non-absorbent of any liquids or gases.
	2) Use of aluminum alloys such as 5xxx and 6xxx series for interior surfaces is observed.
	3) There are no wooden surfaces or wooden materials used.
	4) Interior surfaces are smooth. There are no obstacles taller than 32 μ-inch or 0.8 μm, equivalent to the No.4 surface finish.
	5) There is a limited amount of double metal layers (only if necessary). Otherwise, no double layering design is present.
	6) The vehicle interior is free of any niches such as pits, cracks, corrosion, recesses, open seams, gaps, lap seams, and protruding ledges.
	7) All materials used can withstand 71°C for up to 30 minutes.
C2.Welds, Joints, Fasteners, and Contacts	1) Welding or continuous bonding with a smooth finish on exposed surfaces. If unavoidable, welded joints have a maximum weld height of 1/8" (0.3cm).
	2) Mounting plates, brackets, controller housing, junction boxes, end caps, and other items are welded continuously to the surfaces, not attached via drilled and tapped holes.
	3) There are no corners with sharp angles ($\leq 90^\circ$). Instead, corners are continuous with an absolute minimum radius of 1/8" (0.3cm) and welded at flat surfaces opposite the contact side.
	4) No lap joints present. If necessary, lap joints are only acceptable if they are continuously welded with a smooth finish.
	5) If present, bolts have rubber gasket around the head which would seal the thread and keep dirt and bacteria away.
	6) Gasket insulations are used in the contact area between two metals to prevent galvanic corrosion.
	7) Hermetically sealed spacers are used to allow space between two adjoining surfaces or pieces. The gap is bigger than 1/2" (1.3cm) to allow mechanical cleaning.
C3.Fittings, Enclosures and Human-machine interfaces	1) Fittings can be removed easily for cleaning and disinfecting.
	2) Palm-nut style or "T-wing" fasteners are used instead of hex or dome nuts.
	3) Push buttons, valve handles, switches, and touchscreens are mounted and sealed properly to prevent harboring of microbes inside. The surfaces can handle harsh chemicals during cleaning process. Electronic housings are rated IP69K sealing.
C4.Hollow areas and Pockets	1) Interior structures with hollow inside are sturdy and free from holes or crevices that could trap organic matter.
	2) Hollow tube constructions such as frame members are fully sealed by continuous welding.
	3) There are no fastener penetrations into hollow tubes.
	4) There are no dead spaces, dead ends, pockets, or other framework design that can trap organic matter.
C5.Framework	1) Horizontal ledges are rounded or angled to prevent water from pooling.
	2) The roof of enclosures is inclined forward (e.g., 30° angle) to avoid water pooling and improve visibility.
C6.Drainage System	1) The vehicle has a reliable drainage system that does not leak outside.
	a. Intact sump or holding tank that contains the waste product
C7.Ventilation System	2) Upper deck waste does not drop down on the animals below the deck and in their water and feed.
	1) The materials used in the ventilation system are durable and waterproof/water-resistant to handle moisture. The ventilation system can be dismantled easily if repairs or further cleaning is required.
C8.Vehicle Exterior	1) Pressure washer can reach all the surface on the exterior of the vehicle. There are no small gaps that will prevent mechanical cleaning and disinfection.

Table 2. Overview of the different components included in the trailer checklist for safety

Key Area	Description		
S1.Interior of livestock vehicle	1) There are no sharp edges, projections, and gaps that can cause injury to animals and personnel.		
	2) Mechanical and electrical installations are inaccessible to livestock.		
	3) Lights are sealed and mounted flush with the walls/ceiling or firm at an area inaccessible to livestock.		
S2.Deck Height	1) The deck height allows the animals to stand comfortably without any part of their body touching or rubbing on the deck's ceiling.		
	2) Minimum deck height with reference to the pig's live weight (5% tolerance):		
	a. 45cm for <10kg	b. 62cm for 10-25kg	c. 70cm for 50-70kg
	d. 88cm for 100-120kg	e. 100cm for >120kg	
S3.Partitions, Barriers, and Fittings	1) Partitions and barriers are strong and sturdy enough to withstand >120kg pigs.		
	2) Partitions have solid surfaces to prevent animals from harming their neighbour.		
	3) Partitions have no gaps significant enough for animals to get their body parts stuck.		
	4) Barriers are tall enough to prevent pigs from climbing or jumping over.		
	5) Barriers are present and preventive when the load-door is open.		
	6) Fittings, such as latches, pins, slam shut mechanisms, are quick, safe, and easy to use.		
S4.Ramp Side Gates or Lateral Protections	1) Ramp side gates are tall enough to prevent pigs from falling or pigs from jumping off during loading/unloading. Side gate minimum height is 35" (90cm) for market pigs.		
	2) Ramp side gates have solid walls for preventive purposes.		
S5.Lift Platform (if present)	1) The platform has safety barriers with sufficient height and solid walls to prevent pigs from falling off and being stuck on gaps.		
S6.Emergency/Contingency Plan	1) The transporter is well trained and educated on animal transport.		
	2) The transporter has a well-thought-out emergency plan, which includes safe evacuation of animals, procedures during a mechanical breakdown, equipment breakdown, road traffic accidents, extreme weather, road closures, etc.		
	3) Emergency contact sheets and procedure protocols are written and available.		

Table 3. An overview of the different components included in the trailer checklist for animal health and welfare

Key Area	Description		
W1.Roof	1) The vehicle's roof has proper insulation and can maintain the ambient temperature inside, even during hot summer days or freezing winter days.		
	2) The roof is painted with light colours to help with insulation during summer days.		
W2.Floors	1) The floors are strong and sturdy to support the animal's weight.		
	2) The floors are free of protrusions and gaps.		
	3) Anti-slip matting like chequer-plates, grooves, fixed or removable rubber mats, etc., are installed.		
W3.Ramps (internal and external)	1) The ramps have a maximum angle of 20° with a tolerance of +/- 5°.		
	2) Ramps with a slope steeper than 10° angle are fitted with 1" (2.5cm) or higher foot battens or secure footholds that are 8" (20cm) apart for market pigs and 4" (10cm) apart for nursery pigs.		
	3) Ramps are 35" (90cm) to 39" (100cm) wide with no gaps.		
W4.Steps	1) The fitting of the ramps from the vehicle to the ground must be continuous and flush. There is no need for animals to step onto the ramp and off the ramp. If the ramp is not flush with the platforms, steps can not exceed 8" (21cm) in height and 2" (6cm) in gaps. The steps cannot be taller than the pig's knees.		
W5.Lengths and Heights of Partitions	1) The pen's length is measured to ensure the animals do not move around too much during travel and sudden change in speed. The pen has a maximum length of 122" (310cm).		
	2) Partitions between pens are at least 30" (76cm) tall.		
	3) Partitions are present such that no more than 30 market pigs or 50 feeder pigs are in a section.		
	For long-distance transport:		
	4) Pen lengths and barrier heights are adjustable to suit the transported animals.		
W6.Floor Area and Height of Compartment	1) The pen has enough space for pigs to lie down and stand up in their natural position.		
	2) The pen has adequate headspace to allow a flow of fresh air from the ventilation system to reach all animals.		
	a. Minimum deck height with reference to the pig's live weight (5% tolerance):		
	i. 45cm for <10kg	ii. 62cm for 10-25kg	iii. 70cm for 50-70kg
	iv. 88cm for 100-120kg	v. 100cm for >120kg	

Table 3. ... continued

Key Area	Description
W7.Artificial Lighting	1) Lights must be present or available during transport to carry out tasks and allow animal inspection.
	2) Internal light fixtures are mounted flush on walls or ceilings or fixed where they are inaccessible to animals.
	3) Rear-end spotlights are available to aid loading/unloading with a minimum of 50 lux of lighting.
	4) Rear-end interior headlights point toward the front of the compartment.
W8.Access	1) There are methods for visual inspections available onboard.
	2) Equipment to access specific openings are available during transport.
	3) A person can inspect the animal compartment from outside quickly.
W9.Ventilation	1) Both passive and mechanical ventilation is variable and adjustable according to animal needs.
	2) The ventilation system is reliable and can regulate the interior climate for transport duration, and any emergency stops.
	3) The intake of the ventilation system is not directly under any exhaust of the vehicle.
	For long-distance transport:
	4) The ventilation system maintains an ambient temperature of 5°C to 30°C (+/- 5°C) inside the animal compartments.
	5) The ventilation system can operate independently of the vehicle's engine for a minimum of 4 hours.
W10.Temperature Monitoring System	6) The animal compartment has enough apertures to provide ventilation in events where the fans fail or power failures.
	For long-distance transport:
	1) Temperature sensors are located 32" (80cm) to 39" (100cm) above the floor of each deck. Sensors protected under an IP69K rated housing.
	2) Every 15 minutes or less, the system reads the temperature and records it.
W11.Cooling System	3) There is a minimum of four temperature probes per deck.
	4) The system has alarms that will go off when temperatures go above the threshold and alert the transporter.
	1) Misters, sprinklers, or spray systems are present to cool down animals at temperatures above 25°C.
	W12.Water System
W12.Water System	1) There is an onboard water supply of 1.5% maximum payload available for the animals.
	2) The water tank is easily refillable, accessible (water level), and easily cleanable.
	3) The water lines are secured, sealed tight, and inaccessible to animals.
	4) The transporter can water the animals during system failures.
	For long-distance transport:
	5) Animals have limited access to water supply during transport to prevent wastage, slipping, and wet standing. The transporter can easily control the water supply.
W13.Feeds and Feeding Equipment	6) Drinkers are suitable and adjustable to accommodate the transported animals.
	a. Drinkers are positioned 12" (30cm) from the floor for weaned piglets and 20" (50cm) for market pigs.
	For long-distance transport:
	1) The vehicle carries sufficient and appropriate feed for the transported animals.
W14.Distractions	2) The feed storage protects the feed from weather, contaminants and inaccessible to animals.
	3) Feeders are installed correctly and secured so that animals cannot play with them during transport.
	4) The transporter can easily access and refill the feeders during stopovers if the animals need feed.
	1) There are no distractions that scare the animals or cause them to stop or balk during loading/unloading. Rubber stoppers are installed to mute metal to metal contact.
	2) The floors are not shiny or reflective, even when wet.
	3) The entrance is illuminated with indirect lighting that will not shine on the animal's face.
	4) There are no loose objects in the animal compartment.
	5) The floors are even without any sudden drop or elevation. The loader can install a false solid floor to provide a continuous walking surface.
6) Pneumatic equipment does not produce noise levels higher than 40dB. Preferably turned off during loading. Silencers are installed to reduce the noise level from equipment.	
7) Rubber stoppers are installed to silence metal on metal contacts.	
8) Fan positions are adjustable to prevent air currents from blowing on animal's faces.	