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Investigation of pig transports for more than 8 hours in cold and warm weather conditions and of the requirements for ventilation during the transport

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Summary

To serve as documentation of the ventilation conditions on a multi tiered transport vehicle during transports of pigs over longer periods an investigation has been carried out supported by the Danish Pig Levy Fund and in cooperation with the Institut für Tierhygeine,Tierschutz und Nutztierethologie der TiHo Hannover, Germany.

The investigation comprises 4 transports with piglets weighing approx. 25 kg, 4 transports of slaughter pigs weighing approx. 100 kg and 4 transports of sows weighing >130 kg.

For each category of animals there were 2 transports during the summer period at an outdoor temperature of up to approx. 25°C and 2 transports during the winter period at an outdoor temperature around 0°C.

During the transports the temperatures and humidity were measured in the individual compartment. CO_2-level was measured on lower and upper decks. Heart rate was measured on some of the animals, and video surveillance was carried out in selected compartments on the vehicle. On arrival at the place of destination, body core temperature was measured and the general condition of the animals was evaluated by veterinarians from the Institut für Tierhygeine, Tierschutz und Nutztierethologie der TiHo Hannover, Germany.

Temperature, relative humidity and CO_2 measurements

Registrations of temperature and relative humidity measured in the different compartments on the fore-carriage as well as on the hanger give a clear pattern of where to install measuring equipment for registration of temperature in accordance with the EU legislation. Using the front compartments on lower tiers and the rear compartments on upper tiers for registration of temperatures will give a good picture of temperature levels in the rest of the compartments on the vehicle. The measuring points can be used for observing the registrations required by EU legislation.

The level of relative humidity in connection with temperature levels does not give any reason for concern. It seems that provided the limits, 5 – 30 °C ±5°C as stated in the EU legislation are observed, pigs should not suffer any harm as long as the vehicle is moving but on a stopped vehicle with pigs, ventilation is necessary to avoid critical combinations of temperature and humidity. The measurements indicate that only measuring of temperature during transports can be used to prevent unfortunate combinations of temperature and humidity, however, with a larger safety margin than when measuring both temperature and humidity. The lack of

proper (for daily use and under practical conditions) humidity measuring equipment should be born in mind.

No CO_2 concentration above 3360 ppm was measured during the investigation. The Danish and the German working occupational health threshold for an 8 hour working day (Working Environment Service) is 5000 ppm CO_2. CIGR rules and the German DIN norm 18910 (DIN 2004) recommend CO_2 concentrations between animals not to be higher than 3000 ppm to ensure good air quality and welfare for animals kept in confinements and buildings. This can be applied to transport too. The limit of 3000 ppm CO_2 is more a ventilation indicator than causes any harm to animal or man. Ventilation rates can be calculated in farm animal buildings by the CO_2 balance calculation method (DIN 2004). The lower level for animals is attributed to the fact that humans are spending usually up to 8 hours in a working atmosphere, many animals spend all their life in the same building. The discussion shows that there is no negative health effect expected in animals caused by 3000 ppm CO_2 or even 5000 ppm CO_2 for a transport up to 8 to 10 hours. In case of ventilation failure on a lorry, animals may die from heat stress, not from elevated CO_2 levels. CO2 concentration higher than 1% may trigger the respiration centre in the brain of pigs and increase respiration frequency. There are usually sufficient gaps and openings in the walls of the vehicles used for transport that the CO_2 can escape easily, but in some occasions not enough space to prevent increased temperature and relative humidity. Failure of ventilation will be signalled by increasing temperature and relative humidity, more promptly than by CO_2 and this was seen when transporting sows in hot weather conditions, where the combinations temperature and relative humidity exceeded critical levels on a laden non moving vehicle and forced ventilation probably could have changed this situation by decreasing of the temperature and relative humidity.

The used vehicle in this investigation was equipped with mechanical ventilation, sensors to measure temperature in the vehicle body and water sprinkling systems to cool the pigs in warm weather conditions and create a moderate micro-climate on the vehicle. Despite Installation of mechanical ventilation on the vehicle in use, some sows died during one of the transports and on this transport the vehicle was non moving, for approx. one hour, and fully laden, and in this situation forced ventilation should have been in use. There is no recommendation how to use mechanical ventilation and even saying when forced ventilation should be recommended, and one goal in the project was to find these limits and now it is possible to set up some guidelines.

Behaviour:

During transport, the pigs irrespective of size have preferred to lie down in groups making a free space in the compartments of 20-30 % of the actual floor space. There has been a normal level of activity and as seen in previous transport investigations a very low frequency of aggression and fights. The low frequency of fighting seen on the cameras installed in 4 of the 18 compartments (transports with piglets) do not correspond to the check at offloading where several fighting marks were seen on the piglets indicating that the transport alone could not be held responsible for this.

Heart rate monitoring:

It was not possible to measure the heart rate of piglets during transport because there is no equipment available which can be used on these small animals under practical conditions, without prior surgery comprising their welfare.

The heart rate monitoring on slaughter pigs and sows did not always work satisfactory under the practical conditions of commercial transport. The main reason of failure was the loss of the body belts with the integrated

sensors or data was lost during transmission between the sensors and the receiver. Therefore it was not possible to have full record of one animal during the full transport time. However, the data obtained were sufficient to assess the heart rate of the animals which was at the same level as pigs for slaughter under housing condition or slightly higher and did not differ from experiences of similar investigations and with similar vehicle construction in use. In general, sows showed a slightly higher heart rate level than slaughter pigs, thus the basic level for sows on housing conditions is not measured and it is not known if the heart rate level for sows, in general is higher than pigs for slaughter.

Veterinary conditions:

Prior to transport, all pigs have been checked by a veterinarian from the Danish Regional Veterinary and Food Control Authority. All pigs were considered fit for transport.

The German partner inspected the animals on arrival at the slaughter houses, removed the heart rate monitors and stored the gathered data for shipment back to Denmark.

Attachment 6 summarises the facts and observations made when the 11 of a total of 12 transports arrived at the abattoirs. In total, 2643 pigs were transported and inspected at arrival: 333 sows (4 transports, 2 in summer, 2 in winter), 329 fatteners (3 transports, 2 in summer, 1 in winter) and 1981 piglets (2 in summer, 2 in winter).

The mortality rate was measured on transports of 6 to 10 hours over a period of 1 year (2006), and the level was found to be more or less the same as the Danish national level. The mortality rate was 0.006%, 0.012% and 0.12% for piglets, slaughter pigs and sows respectively corresponding to the Danish national level of (piglets, however, not known), 0.011% for slaughter pigs and 0.11% for sows, and which is considered as the lowest in the EU in general.

Six out of 333 sows (1.8 %) died during transport or directly after arrival on the loading ramp of the abattoir, 5 in summer and one animal in winter on the ramp because of heart failure. Four of the five who died under summer conditions (12th September 2006) were found dead in the rear pens of the lorry. On this day the vehicle was fully laden and non moving for more than one hour (see also the chapter sows: temperature and relative humidity). 18 sows (5.4 %) showed injuries such as haematomas, claw injures and skin scratches. Six sows (1.8 %) were lame and two showed typical signs of cannibalism. Two sows arrived at the abattoir as “downers” (0.6 %) and were unable to stand up (12th September 2006).

None of the fattening pigs died during or directly after transport. However, after one of the summer transports many animals showed skin lesions and one pig lost an eye by injury (7th September 2006). These animals were badly treated on the abattoir, beaten up and put in an overcrowded waiting pen resulting in unrest and fighting. After one of the transport with fattening pig (24th February 2006) one pig was found lame on arrival. The unloading ramp in that abattoir was with 25 ° steeper than the allowed angle of 20 °. The day before the same steep angle of the unloading pen did not cause any harm or disturbance to the animals when gently treated.

None of the piglets died, neither during the summer nor the winter transports. The main problem observed was cannibalism during the two transports during winter transport, about 10 % of the animals showed typical symptoms. The observed symptoms of cannibalism in piglets are trace back to conditions on farm. On transport (15th September 2006) many piglets showed skin damages caused by fighting and unrest and as none or only a few piglets was seen fighting during the video recordings, also these incidents can have been caused on the farm. Single cases of bad handling

were due to personal misbehaviour of members of the staff of the abattoir (see transport 13th September 2006).

The results show that health and well-being of the transported animals depend on many factors such as season, age, animal density, composition of the group and last but not least on handling by staff. The main risk factors seem to be hot weather conditions in combination with rather high relative humidity and low air movement as well as high body mass (sows) which can lead to fighting, skin damages and other injuries just as the camera surveying the compartments showed/confirmed a low frequency of fighting.

Final conclusion:

The investigation has shown that transport of piglets, slaughter pigs and sows for 0 to 10 hours can have negative effects on the pigs' health and wellbeing. This depends very much on the origin of the animals and animal density during loading but mostly on the handling by staff.

On the two transports with DOA pigs, the vehicle was at a stand-still or driving very slowly for a longer period of time and forced ventilation should have been in use.The ambient temperature and relative humidity on the lorry and the body weight seem to be main risk factors for DOA (dead on arrival) because all animals which died during the investigations were on summer transports (sows). Temperature, relative humidity and CO_2 have to some extent been above the Live Weather Safety Index level "alert/danger", and close to the level "danger/emergency" yet below the limits required by the European Transport Regulation. CO_2 does not play a role with respect to animal health and welfare.

Most transported animals have shown normal behaviour during transport and at arrival. However, on some transports with high body mass, skin damage, ear biting and other fresh injuries indicate a certain degree of aggressions and fighting. Since the camera surveillance showed a very low frequency of fighting, it cannot be said whether these injuries come from housing conditions or during collection or lairage, but pigs climbing on each in vehicle compartments other were seen while free flooring space was still seen (20-30% floor area).

The ventilation openings during the transports seem to have been sufficient during the entire transport. It is, however, important to advise the driver when the mechanical ventilation and the sprinkling system are to be activated.

The average temperatures in the vehicle body have during the winter period been between 4.4 and 24.7°C and the corresponding outdoor temperatures were 1.0 to 5.9°C and 18 to 29.3°C respectively. The temperatures measured were natural temperatures without use of mechanical ventilation. The mechanical ventilation should have been started when the temperature got beyond 20°C. This would have kept the temperature in the compartments down (present EU legislation demands temperatures between 5 and 30°C ±5°C).

The relative humidity was occasionally above 90%, thus however, primarily during the winter period with low temperatures in the vehicle body and has thus not been critical. Two transports, though, in the summer, with piglets and sows, the relative humidity got above respectively 90% and 60% for longer periods and in combination with the temperatures the mechanical ventilation system should have been activated.

The CO_2 level has during the transport in general been below 3000 ppm which is the value used to evaluate whether the air change is sufficient. In total 6 measurements was between 3310 and 3360 ppm, in 3 different compartments and for transport both summer and winter and for a

maximum period of 10 minutes.

Registrations of heart rate and behaviour among the pigs revealed more activity among piglets and sows than among slaughter pigs.
Heart rate monitoring did not deviate from known heart rate levels.

Veterinary inspection was carried out before start of transport and upon arrival at destination. Before start of transport a stringent sorting procedure was performed as required by the Danish legislation. No animals were, however, rejected, but the control in Germany showed some injuries, thus it's wasn't possible to divide into incidents caused by the transport or incidents happening before transport starting up (e.g. housing and collecting stall just before transport).

There has been a lack of proper information, how to use the vehicle when driving, a set of guidelines, but this has been a possibility carrying through this project (see Final conclusion).
There must be information access on the vehicle, in the drivers cabin, informing about the temperatures in the compartments and how the driver must react to this information, see also "guidelines, proposal" below.

Guidelines, proposal

- Vehicles should be provided with mechanic ventilation system (MVS)
- MVS should be started up when the temperature is above 20-21^{o}C to keep compartment temperatures below 24^{o}C.
- Ventilation openings of 100 mm on one side of the vehicle and closed on the other side seems to suit transports during winter (outdoor temperatures below 10.15^{o}C)
- Ventilation openings of nominal 300 mm (must also be ≥20% of floor area) can be calculated as "free space" with reduction of bars etc. down to 250 mm.
- Misting system can be used when temperatures are above 24^{o}C, but only for short periods of a few seconds, yet the system can be used several time during an hour (the optimum interval is not known)
- The drivers must be able to control the temperature (and RH?) in the warmest/coldest compartments from the driver's cabin
- The drivers must know these guidelines and they must be kept in the driver's cabin and be in a language that the driver can read and understand

Introduction

Danish legislation has for many years made a demand for mechanical ventilation on multi-tiered vehicles for transport of pigs. This demand has now become part of the EU legislation for transportation for more than 8 hours and has been implemented via EU Regulation (E) No. 1/2005 dated 22 December 2004.

The subject has previously been dealt with in an EU working group: *Opinion of the Scientific Panel on Animal Health and Welfare on a request from the Commission related to Standards for the microclimate inside animal road transport vehicles (EFSA 2004).* We may thus assume that the EU in time will incorporate further demands on ventilation in their legislation. As will appear from the report from the EU Committee, only limited documentation exists in relation to the effect of ventilation conditions during transports of pigs for more than 8 hours or in relation to transports with piglets, slaughter pigs and sows carried out during warm and cold periods.

This situation is not satisfactory to hauliers just as it is a precarious matter because the aim for a better animal welfare may easily be overshadowed by undocumented demands that will not ensure the best possible welfare to the animals.

The missing documentation may result in vehicle constructors not always being in the clear with respect to conditions relating to design of truck bodies and the level of investment required.

These things form basis for initiation of the investigation that is reported in this document.

Purpose and aim

The purpose of the investigation was to document the actual ventilation conditions on a multi-tiered transport vehicle and to substantiate:

- The need for natural and mechanical ventilation
- Good animal welfare based on results from investigations
- Whether a need exists for heating of truck bodies used for transport of pigs of approx. 25 kg, and if so what does this involve
- Future design and use of ventilation equipment and sprinkling system, if required

The results can also be used in discussions with the authorities and animal welfare organisations and thus contribute to a new code of practice based on documented facts.

Materials and methods

Test Vehicle

The transport vehicle used for the investigation has been designed in accordance with instructions given in the Manual for Pig Transports (named: HST), written and edited by Danish Meat Research Institute, except for one thing.

In stead of using rubber surface as flooring in the transport vehicle, a non-skid aluminium surface was used for flooring.

The same vehicle was used for all experiments/transports.

Type of vehicle

The transport vehicle comprises a fore carriage and a hanger.

The chassis of the fore carriage is of the make Volvo FM12 with a long driver's cab and complete air suspension.

The chassis of the hanger has been constructed by the company of Menke, 49575 Werite, Germany and is also equipped with complete air suspension.

Vehicle body

The vehicle body of the fore-carriage as well as of the hanger was also built by the company of Menke, 49575 Werite, Germany.

The walls have two-ply aluminium profiles that provide insulation from the stagnant air between the plates.

The roof has two layers of glass fibres with a 50 mm insulation material between the layers.

The individual tier has non-skid ribbed aluminium flooring.

On the sides of the vehicle body are placed ventilation openings for each compartment. The ventilation openings are manually operable. Depending on the outside temperature and the natural ventilation, mechanical ventilation can be activated in all compartments.

The mechanical ventilators are placed on the same level above the floor as the openings for natural ventilation.

For use during warm periods, a sprinkler system has been mounted in the vehicle body.

The mechanical ventilation as well as the misting system is not operated by the actual temperature in the truck body. Sensors mounted on the front-board of the lower, front compartment on the fore carriage gives information to the driver of actual temperatures via a display in the driver's cab, and the driver has to start-up the mechanical ventilation and misting system when he receives the information on the display.

Figure 1.

The transport vehicle used for the investigation comprises a fore carriage and a hanger. The picture on the left shows the vehicle body of the fore carriage with ventilation openings open. The picture on the right shows the body of the hanger with ventilation openings closed.

Tier and compartment

The tiers on the fore carriage and the hanger are mobile and adjustable for transports in 1, 2 or 3 tiers.

On each tier have been mounted two compartment gates that divide the tier into 3 compartments.

The compartment gates are of aluminium with a plate covering the lower 600 mm of the gate and with bars above the plate. The compartment gates have a total height of 800 mm and will ensure ventilation between and through the individual compartments.

Floor space on the individual compartments

Table 1 and 2 show the free floor space of the individual compartments on the fore-carriage and the hanger.

Table 1

Sq meter	Compartment 1	Compartment 2	Compartment 3
Upper tier	5.33	5.33	5.33
Middle tier	5.33	5.33	5.33
Lower tier	5.33	5.33	5.33

Table 2

Sq meter	Compartment 1	Compartment 2	Compartment 3
Upper tier	5.79	5.79	5.79
Middle tier	5.79	5.79	5.79
Lower tier	5.79	5.79	5.79

The individual compartments on the fore carriage and the hanger can hold 12.69 and 13.78 pigs weighing100 kg respectively with a space allocation of 0.42 m^2/pig.

Tier heights

Tier heights on vehicles during transport are shown in the table below:

Table 3

	Fore- carriage 2 tiers	Fore-carriage 3 tiers	Hanger 2 tiers	Hanger 3 tiers
Upper tier	1.35 m	0.94 m	1.5 m	1.0 m
Middle tier	-	0.94 m	-	1.0 m
Lower tier	1.33 m	0.94 m	1.5 m	1.0 m

Ventilation and sprinkling

Openings for natural ventilation have been evenly distributed along the sides of the carriage. The openings have a max. nominal height of 350 mm (actual height was 310 mm) and a length of 820 mm, except the first row on the fore-carriage which is 700 mm long. The openings can be adjusted independently.

The carriages have furthermore been equipped with mechanical ventilation. There are 3 fans mounted on the lower tier, 3 on the middle tier and 3 on the upper tier for each individual compartment.

The fans have been mounted on the same level as the openings for natural ventilation and all ventilation openings are the same on all tiers. See pictures below (Figure 2).

Each fan, type 24 V and with a diameter of 255 mm, provides airflow of 1100 m^3/h and thus complies with current EU regulations for at least 60 m^3/hour/kN live animal.

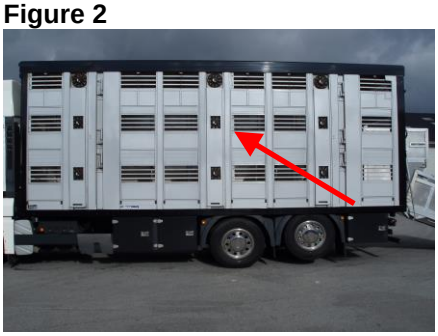
Ventilation and misting are semi-automatically controlled.

The transport company has no written guidelines as to when mechanical ventilation and sprinkling system are to be started. The HST manual from DMRI describes the constructions only and not how to use them.

The drivers have informed that normally they activate the ventilation and sprinkling system as follows:

- The ventilators: when the temperature in the compartment reached approx. 20°C
- Misting system: when temperatures get above 25°C

Figure 2



Situation of the ventilation openings and their size in relation to floor space

In the tables below are shown at which height above the floor the ventilation openings are situated and the relation in percentage between the ventilation openings and the floor space. The EU regulation 1/2005 dated 22 December 2004 requires that the area of the ventilation opening must be sufficient which has previously be interpreted as being 20% of the floor space. Design of truck bodies meets this requirement.

The regulation does not contain anything as to the calculation being in relation to net or gross area. In the investigation reported here, the size of the openings meets the requirements in relation to the gross area and the figures are shown in Table 4 and 5.

Table 4 - Situation and area of the ventilation gabs on the fore-carriage

Compartment No.	**1**	**2**	**3**
Upper tier			
m above floor	0.41	0.41	0.41
m^2 and % of floor space	1.12 20.98%	1.12 20.98%	1.12 20.98%
Middle tier			
m above floor	0.54	0.54	0.54
m^2 and % of floor space	1.12 20.98	1.12 20.98%	1.12 20.98%
Lower tier			
m above floor	0.52	0.52	0.52
m^2 and % of floor space	1.12 20.98 %	1.12 20.98%	1.12 20.98%

Table 5 – Situation and area of the ventilation gabs on the hanger

Compartment No.	**1**	**2**	**3**
Upper tier			
m above floor	0.45	0.45	0.45
m^2 and % of floor space	1.16 20.03%	1.16 20.03%	1.16 20.03%
Middle tier			
m above floor	0.60	0.60	0.60
m^2 and % of floor space	1.16 20.03%	1.16 20.03%	1.16 20.03%
Lower tier			
m above floor	0.60	0.60	0.60
m^2 and % of floor space	1.16 20.03 %	1.16 20.03%	1.16 20.03%

Openings for natural ventilation of the individual transports

Ventilation openings have been adjusted in accordance with time of year and type of pigs transported. During summer the openings in both sides of the truck are identical whereas in winter the ventilation openings vary from left to right side of the truck body.

Table 6 - Size of ventilation openings in mm during summer and winter transports respectively

	Piglets (approx. 25 kg)	**Pigs (approx. 100 kg)**	**Sows >130 kg (ave. 250 kg)**
Summer	310	310	310
Winter (right side)	"Closed"	"Closed"	"Closed"
Winter (left side)	60	100	100

"Closed" indicates a natural chink of some 5 mm between the plates for adjustment of the ventilation openings and the truck body.

Measuring equipment

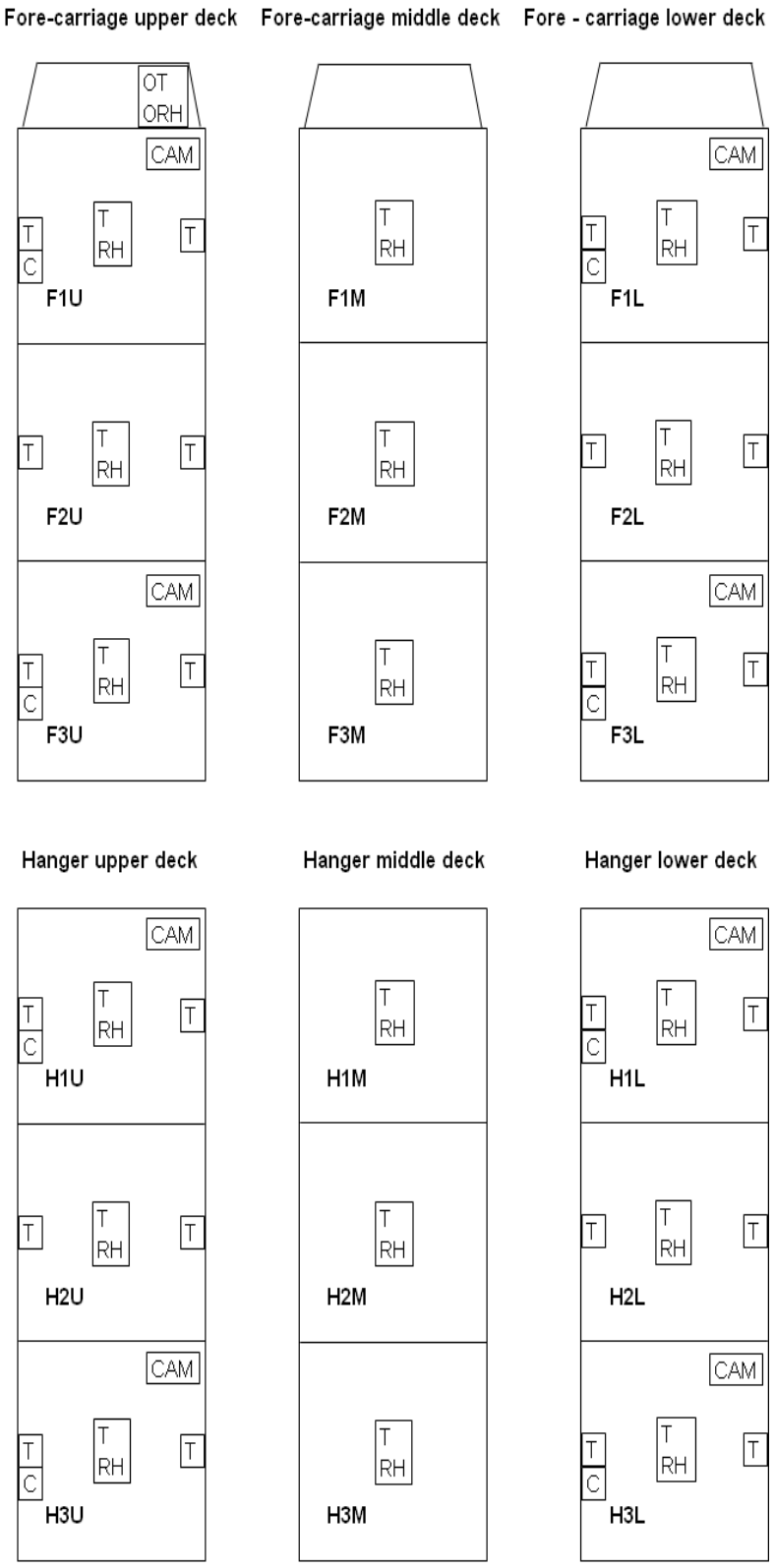
Measuring equipment for registration of temperatures and humidity had been installed in all compartments on the vehicle.

CO_2-content was measured in the front and rear compartments on the lower and upper tiers of the fore-carriage and hanger. All measuring points are situated 600 mm (±50 mm) above the floor.

Measuring points are shown in Figure 3 overleaf.

Placing of measuring equipment

Figure 3 – Principle sketch of truck body and placing of measuring equipment.



Explanation of codes in the compartments:

F = Fore-carriage	H = Hanger	
1 = Front compartment	2 = Middle compartment	3 = Rear compartment
U = Upper tier	M = Middle tier	L = Lower tier

Explanation of codes for measuring points and camera

T = Temperature	OT = Outdoor temp.
RH = Relative humidity	ORH = Outdoor relative humidity
C = CO_2	
CAM = Camera *	

*) Cameras have not been located at all 8 positions during all transports. For each category of animal on summer transports as well as on winter transports there has been video surveillance using 4 cameras on the upper tier and 4 cameras on the lower tier.

Temperature and humidity measuring equipment

For measuring of temperatures have been used loggers of the type Gemini Data Loggers, Tinytag Plus, model TG12-0017/32K, with temperature range -40°C to + 85°C.

For measuring of temperature and humidity at the same measuring point has been used combined loggers of the type Gemini Data Loggers, Tynitag Ultra, model tgu-1500 with temperature range -30°C to +50°C and Relative Humidity (RH) range from 0% to 95%.

Measurement equipment has been mounted onto the underside of the above tier or on the upper tier under the roof.

Measurements were carried out every 5 minutes during the entire transport.

CO_2 measuring equipment

The CO_2 measuring equipment used is from the company of N. Veng, D-7870 Roslev, Denmark, type VE18°C and with 9 entrance gates.

Measuring principle is infrared red (IR) multiflex with suction reference, flow speed of 0.7 l/min. and a range of 0-10,000 ppm.

Special tubes were drawn from the measuring equipment to the locations of the measuring points in the front and rear compartments on lower and upper tier of the fore-carriage and the hanger.

Measurements were carried out every 9 minutes during the entire transport.

Heart rate (HR) monitor

For measuring the heart rate (HR) of pigs was used a HR monitor of the type Polar Electro, model S810i and HR belts, type SF. Contact was achieved through cupper electrodes mounted with sponges and a contact media comprising water and exploration cream.

Measurements were carried out every 5 seconds of the entire transport. To clarify the curves relating to slaughter pigs and sows state the average HR per minute.

Camera surveillance

For camera surveillance has been used a hard disc from Talbit Co., type DVR-JM1, with internal power supply and IR camera type KD-320S121\N with light level range from 0 lux.

Recordings of 1 minute's duration were made for every 9 minutes during the entire transport. Based on these 1 minute recordings was made a registration of the behaviour of the animals for every 10 seconds, giving a total of 6 registrations per recording shot.

Registrations of animal behaviour have been evaluated as follows:

- Pigs lying, sitting or standing
- One or two-way aggressions or short term fights lasting less than 10 seconds
- Long term fights lasting 10 seconds or more

Transport conditions

For each category – it being piglets, slaughter pigs or sows, 4 transports were carried out. Two during the summer and 2 in winter.

The pigs have been randomly selected and all transports have carried pigs from more than one farmer.

Each category of pigs has been transported separately on fully loaded vehicles, and all transports have been carried out on the same vehicle.

There have been two drivers attached each transport, one of the drivers has been attached all transports.

The duration of all transports have been at least 8 hours counted from time of departure and until the last pig has been offloaded at place of destination.

Number of pigs per compartment per transport in relation to the individual categories of pigs will appear from Tables 7 to 9.

Table 7

Date	Pigs, approx. 25 kg	No. of pigs per room per tier		
		Upper	Middle	Lower
14.03	Fore-carriage	3 x 32	3 x 35	3 x 35
	Hanger	3 x 32	3 x 32	3 x 27
17.03.	Fore-carriage	3 x 30	3 x 30	3 x 30
	Hanger	3 x 30	3 x 30	3 x 30
13.09.	Fore-carriage	3 x 26	3 x 27	3 x 27
	Hanger	3 x 28	3 x 29	3 x 29
15.09.	Fore-carriage	3 x 32	3 x 32	3 x 32
	Hanger	3 x 33	3 x 33	3 x 33

Table 8

Date	Pigs, approx. 100 kg	No. of pigs per room per tier		
		Upper	Middle	Lower
20.02.	Fore-carriage	3 x 12	-	3 x 12
	Hanger	3 x 13	3 x 13	3 x 13
23.02.	Fore-carriage	3 x 12	-	3 x 12
	Hanger	3 x 13	3 x 13	3 x 13
06.09.	Fore-carriage	3 x 12	-	3 x 13
	Hanger	3 x 13	3 x 13	3 x 13
07.09.	Fore-carriage	3 x 12	-	3 x 12
	Hanger	3 x 13 – 1	3 x 13	3 x 13

Table 9

Date	Sows, approx. 130 kg	No. of sows per room per tier		
		Upper	Middle	Lower
21.02.	Fore-carriage	3 x 7	-	3 x 7
	Hanger	3 x 8	-	3 x 8
22.02.	Fore-carriage	3 x 7	-	3 x 7
	Hanger	3 x 8	-	3 x 8
11.09.	Fore-carriage	3 x 7	-	3 x 7
	Hanger	3 x 8	-	3 x 8
12.09.	Fore-carriage	3 x 7	-	3 x 7
	Hanger	3 x 7	-	3 x 8

Fit for transport

Whether an animal is fit for transport or not will be evaluated by a veterinary inspector from the Danish Regional Veterinary and Food Control Authority prior to transport.

It is a demand in Denmark that the supervising veterinary inspects all animals before they are transported to another EU country or to third countries. The veterinarian will evaluate the condition of the animals and check it against the route plan. Based on his evaluation the animals will be declared fit or not fit for transport.

Test plan

Dates for transports appear from Attachment 1.

Planned measurements and registration for the individual compartment will appear from Attachments 2, 3 and 4.

Results and discussion

Results relating to all categories of pigs

The following informs of the general results for the 3 categories of animals transported, followed by the results for the individual category.

Transport equipment and transport pattern

The transport vehicle used for this investigation meet all requirements by the EU legislation. All transports have departed from Denmark for a destination in Germany.

Three categories of pigs were transported, naturally to 3 different final destinations. Piglets were transported to a farm for further fattening, pigs for slaughter to a pig abattoir and sows for slaughter to a sow abattoir. Therefore the total transport time varied up to approx. 2½ hours between the 3 categories of animals

The transports have primarily been on motorways or on secondary roads, with due consideration to the wellbeing of the animals. This means that the way the vehicle body is constructed and the use of air suspension is optimized for transportation of pigs. See references below.

Previous investigations by Christensen, L., and Barton Gade, P. (1995) and Randall, J.M., Stiles, M.A., Geers, R., Schütte, A., Christensen, L. & Bradshaw, R.H. (1995) describe design of pig transport vehicles and the effect of their air suspension system. Both investigations conclude that transport vehicles with optimized vehicle design (ventilation and misting system) and complete air suspension do not have poor microclimatic condition if used properly. Nor do they have vibration frequencies that make the animals transported suffer malaise to any degree for a period of up to 24 hours.

The vehicle used, fulfil these requirements/guidelines, and influence on the animals must therefore be at a minimum; still, practical use may influence handling and the well being of the animals.

Temperature Relative Humidity (RH) CO_2-level

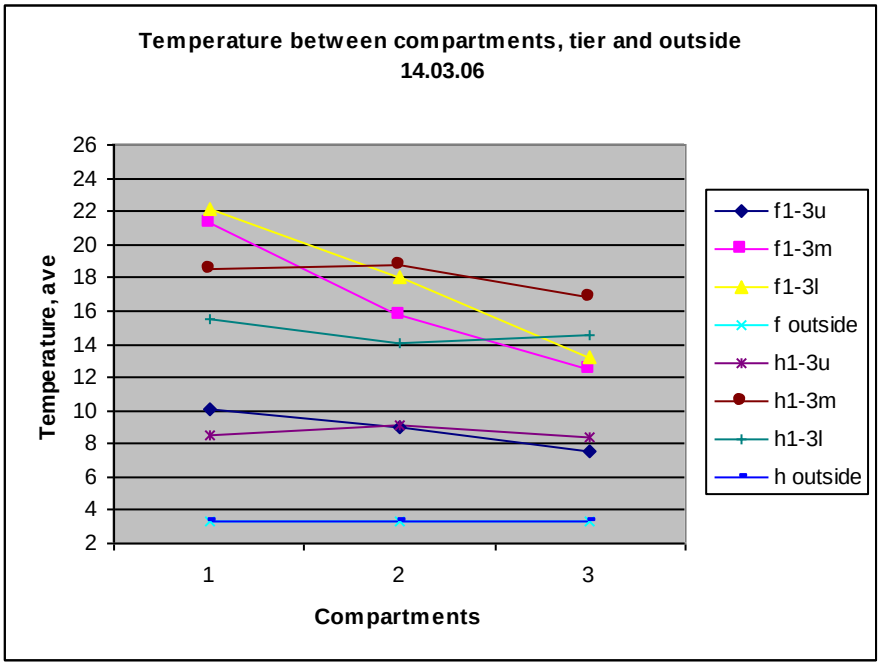
No comparison between piglets, slaughter pigs or sows has been made. Yet, although the individuality is too big with respect to both body heat and evaporation, some common picture is seen in relation to the temperature which in general drops the further back in the vehicle body the compartment is situated; see the following point "*Comparison of temperature between compartments, tier and outdoor".*

For results and discussion please refer the chapters for the individual group. As to the temperature it has to be taken into consideration that measuring has been carried out at varying distance to the pigs and that the temperature among the pigs is approximately 3 to 5°C higher than the figures shown, Christensen, L., and Barton Gade, P., (1997).

Comparison of temperature between compartments, tier and outdoor

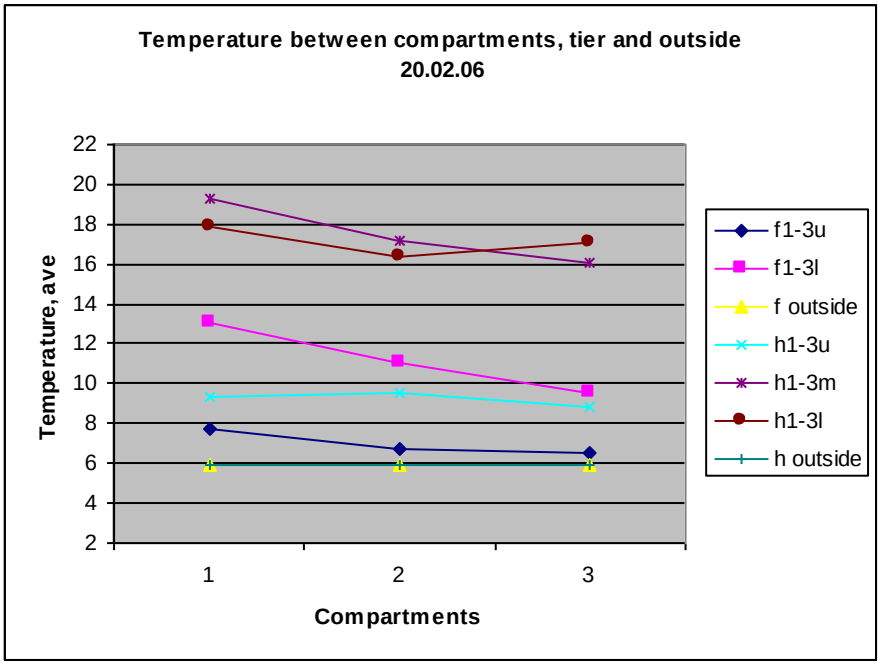
The temperatures between compartments, tier and outside the vehicle on the first day of the winter transport of piglets, slaughter pigs and sows are shown in Figures 4 to 6. The temperature normally drops from the front and to the rear end of the vehicle, and therefore it seems a few times that there is a slight increase in temperature of 0.5 to 1.0°C.

Figure 4 - piglets



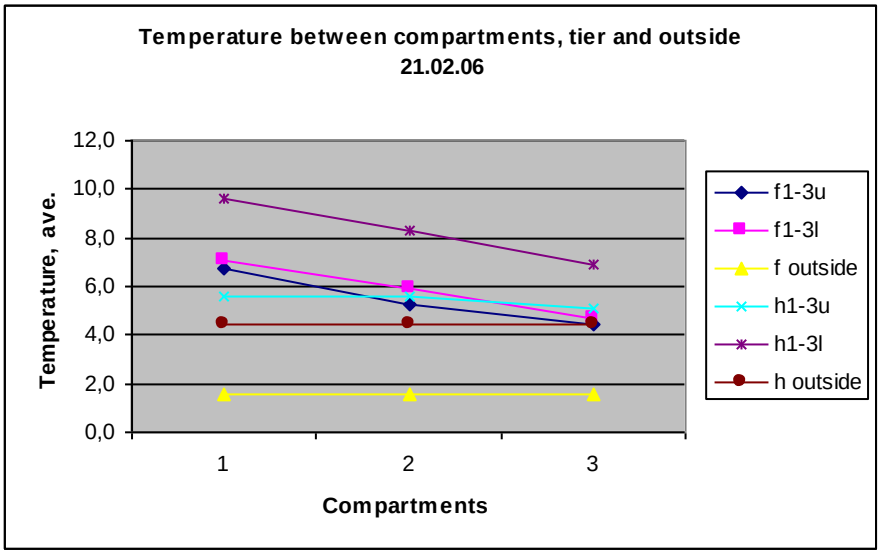
A slight increase in temperature is seen in compartment H2M, H2U and H3L, compared to the neighbouring compartments. The increase in temperature is approx. 0.5°C.

Figure 5 – slaughter pigs



A slight increase in temperature is seen in compartments H2U and H3L compared to the neighbouring compartments. The increase in temperature is approx. 0.5 and 1.0°C.

Figure 6 - sows



The drop in temperature is constant from front to rear end.

For an overview of all transports, see Attachment 5.

Animal behaviour Heart Rate (HR)

The pattern of behaviour between piglets, slaughter pigs and sows varied a lot. Piglets and sows are quite active in periods of 1 to 10 minutes and 1-2 and 4-6 hours respectively after loading, using the free floor space in the compartment. The rest of the group of pigs in each compartment was lying in a tangled heap, therefore the free floor space. After a period of 1-10 minutes of activity the pigs went back to the heap and often tried to get into the middle of the heap, trampling on other pigs, both when leaving and returning to the heap.

Slaughter pigs were lying down during almost the entire transport and only few pigs were standing when the vehicle stopped and they lie down as soon as the vehicle began rolling again.

In all three groups some aggression was seen when pigs climbed on top of each other, but often no reaction was seem from pigs being climbed on.

For results and discussion please refer the chapter on behaviour and heart rate for the individual group.

Veterinarian control

All animals were checked at unloading, and injury and mortality rates were registered, see Attachment 6.

Mortality rate

The mortality rate showed that no piglets or slaughter pigs died during transportation, yet 6 sows died. One sow died on a winter transport and 5 sows died on a summer transport.

It cannot be claimed that the mortality rate is 0 for piglets and slaughter pigs and the rate for sows is 2.4%. Mortality has to be calculated over a period of minimum one year.

Over a period of one year and with transports of between 6 and 10 hours, the figures are as follows:

Year 2006, total	**Transported**	**Dead**	**Dead %**
Piglets	632.453	379	0.006
Slaughter pigs	223.903	268	0.012
Sows	40.839	490	0.12

The national Danish figures for the same period are not known for piglets; for slaughter pigs and sows the figures are 0.011% and 0.11% respectively. The national Danish level is known as the lowest in the EU in general.

Mortality, explanations

As to the sows that died during the transport on 11th September 2006 special focus has been on the figures for temperature and relative humidity to see whether there was an explanation to the incidents in these figures. On the transport of sows on 12th September 2006 the outdoor temperature was a little lower than on the 11th and no sows died.

When looking at the LWSI-curve and the combination of temperature and relative humidity for more than two succeeding measurements, negative combinations were found several times. All these negative combinations were found just after the vehicle had been loaded and when the vehicle was still not moving. This was not the case on the transport on the 12th where the negative combinations were found/ registered during driving, however, only in one compartment (compartment F1, on lower deck) and only for a very short period of 20 minutes.

The figures for 11th September 2006 were as follows:

	Fore carrier		Hanger	
	No. of negative T+RH combinations	RH inside body	No. of negative T+RH combinations	RH inside body
F upper	29	58-66	36	57-71
	1		1	
F lower	0		27	58-73
	0		0	

Green figures are in the LWSI area “alert/danger” and the red figures are in the LWSI area “danger/emergency”.

The temperature in the individual compartments varied from 27.2 to 30°C which is much lower than the EU legislation accepts as a maximum.

The negative combinations between temperature and relative humidity lasted from 15 to 45 minutes, without mechanical ventilation running, and could very well be

the reason for the mortality during this transport just as the mechanical ventilations should have been on.

The question could be asked whether transportation without mechanical ventilation is acceptable at all and whether the high temperatures allowed in the EU legislation are safe, without demanding the vehicles equipped with mechanical ventilation.

For all negative combinations of temperatures and relative humidity, please see Attachment 7.

Piglets weighing approx. 25 kg

Levels of temperature (T), relative humidity (RH) and CO_2 for all piglets transports

An overview covering all transports during summer is shown in Figure 7 below, and an overview covering all transports in winter, in Figure 8.

The figures shown in the columns to the left and right correspond to the 13th (left) and the 15th (right) September. Each deck represents the 3 compartments present per tier.

Figure 7

13+15 09.06	Temperature (T°C), Relative Humidity (RH) and CO_2 per tier								
Tier	Fore carrier					Hanger			
Upper	T	RH	CO2	T out	RH out	T	RH	CO2	T out
ave	**22,4-25,0**	**71-59**	**1310-1236**	**20,8-23,3**	**81-58**	**22,5-24,4**	**74-59**	**1301-1307**	**error-26,3**
min	20,2-20,8	32-41	1113-1058	18,3-19,7	0-37	19,0-18,6	27-41	1065-1065	error-22,8
max	26,4-27,4	98-87	1628-1673	27,6-26,1	99-91	26,6-27,5	99-78	2108-2430	error-28,9
Mid	T	RH				T	RH		
ave	**25,9-27,8**	**61-53**				**28,2-27,4**	**62-55**		
min	22,7-24,3	45-38				23,4-23,9	48-38		
max	31,1-31,8	80-69				31,8-30,2	96-70		
Lower	T	RH	CO2			T	RH	CO2	
ave	**26,3-27,1**	**63-52**	**1422-1350**			**27,1-26,3**	**61-42**	**1249-1240**	
min	23,7-23,9	47-39	1193-1125			24,1-20,4	46-25	1095-1050	
max	30,1-30,9	81-65	2408-2145			30,3-30,1	78-81	1920-1943	

As can be seen the variation between the two transports in summer is only small. The average temperature variation is up to 1.8°C on the fore carrier and up to 1.9°C on the hanger.

The maximum temperature was 31.8°C and highest level was seen on the middle tier, both on the fore carrier and on the hanger. Relative humidity was lowest when the highest temperatures were measured and vice versa.

When 99% RH was measured it was normally only once during a five minute period and normally just after loading or very late in the day, close to midnight. High RH in combination with temperatures beyond 24°C was seldom seen, and if so it lasted from 5 to 25 minutes and then the temperature normally decreased to 24°C or below, which is the LWSI index level “safe/alert”.

The average temperatures in the individual tier on the fore carrier, on the upper, middle and lower deck compared with outdoor temperature showed a higher temperature deviation (highest deviation) from 1.7, 5.1 and 5.5°C respectively and the corresponding measures from the hanger was –1.9, 1.1 and 0°C.

The tier on the fore carrier was most likely influenced by the chassis (motor and transmission) and the hanger had temperatures very similar to the outdoor temperatures and for the upper tier it was even lower.

The CO_2 level was in general low, indicating good ventilation in the compartments. Highest level was normally seen on the lower front compartment (F1L), where it is also normal that the ventilation is poorest.

The figures shown in the columns to the left and right correspond to the 14th (left) and the 17th (right) March. Each deck represents the 3 compartments per tier.

Figure 8

14+17 03.06	Temperature (T°C), Relative Humidity (RH) and CO_2 per tier								
Tier	Fore carrier					Hanger			
Upper	t	RH	CO2	t out	RH out	t	RH	CO2	t out
ave	**8,9-9,3**	**68-74**	**699-914**	**error-2,1**	**error-82**	**8,7-9,5**	**58-59**	**676-933**	**3,3-4,8**
min	5,0-3,4	48-38	540-570	error- -1,0	error-63	5,0-2,7	0-0	510-548	1,1-1,1
max	18,6-16,9	99-99	803-1410	error-5,9	error-94	13,9-16,8	99-99	765-1575	7,0-7,6
Mid	t	RH				t	RH		
ave	**16,5-19,4**	**51-54**				**18,0-18,6**	**49-57**		
min	11,3-9,0	31-39				6,6-3,3	15-16		
max	27,7-25,7	80-89				24,2-25,8	89-98		
Lower	t	RH	CO2			t	RH	CO2	
ave	**17,8-17,8**	**42-51**	**676-788**			**14,7-16,9**	**error-52**	**error-1321**	
min	13,5-9,7	29-40	495-585			0,0-0,5	error-1	error-540	
max	24,7-21,9	63-75	765-983			19,2-22,9	error-96	error-1973	

As shown the variation between the two transports during winter is rather small. The average temperature varies from 0 to 0.4°C on the fore carrier; the variation is thus a little bigger on the middle deck, 0 to 2.9°C. The picture is similar on the hanger, with a variation between 0.6 and 0.8 °C, and 2.2°C on the lower deck.

The minimum temperature was 3.4 and 0°C; lowest level was seen on the upper tier on the fore carrier and the lower tier on the hanger.

High RH in combination with temperatures above 24°C was not seen and all transports were in accordance with the LWSI index level of “safe/alert”.

The average temperatures on the individual tier on the fore carrier, on the upper, middle and lower deck compared with outdoor temperature showed a higher temperature deviation (lowest deviation) from 11.0, 18.6 and 19.9°C respectively and the corresponding measures from the hanger was 5.4, 14.7 and 11.4°C. The lowest temperatures measured on the front carrier were 2.9°C and - 0.4°C on the upper tier, compartment F2U, and on the hanger compartment H2L respectively, and for a rather short time period of 20 and 5 minutes.

The CO_2 level was in general low, indicating good ventilation in the compartments. Highest level was normally seen on the hanger, compartment H3L.

For a complete overview of temperatures, RH and CO_2 on the individual transports and for each compartment, please see Attachment 8.

Temperature

The highest average temperature registered for the longest time was in the compartments closest to the driver’s cabin on the lower and middle decks of the fore-carriage. On the hanger, the highest temperature sequences were found on the middle deck in the front room. The lowest temperature sequences over time were found on the upper deck in the rear compartments on the fore-carriage as well as on the hanger. No seasonal variation was registered, see Figure 9 and 10. Course for temperature measuring points are shown in Attachment 11

Figure 9 *– Summer transports – temperature*

Fore-carriage

	High: 0% Low: 0%	High: 0% Low: 6%	High: 0% **Low: 60%**
	High: 33% Low: 0%	High: 0% Low: 0%	High: 5% Low: 2%
	High: 64% Low: 0%	High: 0% Low: 0%	High: 31% Low: 31%

Hanger

High: 0% Low: 0 %	High: 0% Low: 27%	High: 0% **Low: 35%**
High: 74% Low: 0%	High: -% Low: -%	High: 10% Low: 2%
High: 25% Low: **30%**	High: 4% Low: 0%	High: 5% Low: 1%

Figure 10 *– Winter transports - temperature*

Fore-carriage

	High: 0% Low: 1%	High: 0% Low: 3%	High: 0% **Low: 97%**
	High: 61% Low: 0%	High: 0% Low: 0%	High: 0% Low: 0%
	High: 38% Low: 0%	High: 0% Low: 0%	High: 2% Low: 0%

Hanger

High: 0% Low: 22%	High: 0% Low: 1%	High: 1% **Low: 64%**
High: 63% Low: 0%	High: 53% Low: 0%	High: 8% Low: 0%
High: 4% Low: 0%	High: 0% Low: 6%	High: 0% Low: 4%

Figures 9 and 10 show registration of compartments where the highest and lowest level of temperature occurred for the longest time during transport as a percentage of the transport time.

Relative Humidity (RH)

The highest level of relative humidity was found on the upper decks in the front room on fore-carriage and on the upper deck in the middle room on hanger. Lowest levels measured were found in the front compartments on the lower deck of the fore-carriage. On the hanger the lowest levels were found in the front rooms on the lower deck during summer transports and in the middle room on the middle deck during summer transports, see Figure 11 and 12.

Figure 11 *– Summer transports - RH*

Fore-carriage

	High: 38% Low: 1%	High: 27% Low: 3%	High: 24% Low: 1%
	High: 2% Low: 34%	High: 0% Low: 6%	High: 3% Low: 2%
	High: 2% **Low: 43%**	High: 1% Low: 3%	High: 9% Low: 16%

Hanger

High: 19% Low: 1%	**High: 56%** Low: %	High: 18% Low: 0%
High: 2% Low: 39%	High: -% Low: -%	High: 11% Low: 2%
High: **50%** Low: **42%**	High: 3% **Low: 44%**	High: 3% Low: 16%

***Figure 12**- Winter transports - RH*

	Fore-carriage			Hanger		
	High: 60% Low: 0%	High: 5% Low: 0%	High: 35% Low: 0%	High: 14% Low: 5%	**High: 65%** Low: 11%	High: 21% Low: 5%
	High: 2% Low: 21%	High: 1% Low: 3%	High: 1% Low: 3%	High: 7% Low: 9%	High: 5% **Low: 60%**	High: 8% Low: 10%
	High: 0% **Low: 44%**	High: 0% Low: 29%	High: 0% Low: 3%	High: 1% Low: 36%	High: 0% Low: 28%	High: 11% Low: 14%

Figures 6 and 7 show registration from compartments where the highest and lowest level of relative humidity occurred for the longest time as a percentage of transport time.
Course for RH measuring points are shown in Attachment 14.

CO_2-level

The Danish Working Environment Service allows levels not higher than 5000 ppm and with reference to housing conditions a limit of 3000 ppm has been established. During transports the CO_2 level never got beyond 2610 ppm. Course for CO_2 measuring points are shown in Attachment 17.

CO_2 measurements showed that the highest levels were found on the upper deck on the fore-carriage and in the front rooms of the hanger. Lowest occurrence is found in the upper front room during summer and in the lower rear room during winter on the for-carriage. The lowest occurrence of CO_2 on the hanger was found in the rear compartments irrespective of season.

Registration of compartments where the highest and lowest level of CO_2 occurred for the longest period of time is shown as percentage of transport time, see Figure 13 and 14.

***Figure 13** – Summer transports – CO_2-level*

	Fore-carriage			Hanger		
	High: 9% **Low: 76%**		**High: 50%** Low: 10%	**High: 49%** Low: 12%		High: 17% Low: 25%
	High: 38% Low: 19%		High: 17% Low: 14%	High: **46%** Low: 12%		High: 6% **Low: 74%**

***Figure 14** – Winter transports – CO_2-level*

	Fore-carriage			Hanger		
	High: 55% Low: 25%		High: 43% Low: 32%	High: 40% Low: 39%		High: 33% **Low: 79%**
	High: 6% Low: 25%		High: 6% **Low: 44%**	**High: 90%** Low: 4%		High: 6% Low: 3%

Animal behaviour

The activity among the animals during transport, whether summer or winter transports, were different. The activity rate on the summer transports was steadily declining from start to end of transport. During winter transports a steadily declining activity was observed during the first 5 hours of transport, then there was an increase in activity level for the remaining part of the transport. The end activity was, however, not on the same level as at the beginning of the transport. After approx. 7 hours of transport the activity level dropped to some 30% compared to the level at start of the transport.

Fights among the animals of >10 seconds were not observed. During the first 45 minutes after loading and while the vehicle was still at a stand-still 3 incidents of aggression were observed, all lasting less than 10 seconds and more in the nature of a demonstration.

During the transports the majority of the piglets were lying together in a group such that 20-30% of the floor was free. This area was used by a few animals for activity or exploration.

Video recordings show that a few piglets show an attempt for exploration/ activity in periods of up to 3 hours. 1-2 hours after having been loaded onto the vehicle some piglets were observed to move away from the resting group. Occasionally one animal gets on its feet and move around between the resting group for period of 1 – 10 minutes. Then they lie down again. Other animals use the free space for activity. Animals covered by other animals were observed, but as long as they had their head or snout uncovered there were no reactions.

The number of piglets lying down, sitting or standing during transport is shown in Table 10 below. The number of piglets standing compared to time of transport is shown in Table 11.

Table 10 – Distribution (%) of piglets lying down, sitting or standing

	Lying down	**Sitting**	**Standing**
Winter	62.4	9.1	28.5
Summer	86.3	3.5	10.2

Table 11 – Distribution (%) of piglets standing compared to time of transport

Hours	1	3	5	7	9
Winter	79.0	41.4	14.3	24.0	22.2
Summer	16.9	13.3	10.6	6.0	6.8

Figures 15 and 16 illustrate the corresponding distribution for 2 randomly chosen transports carried out during winter and summer periods.

Figure 15 – Distribution of piglets lying down, sitting or standing during a randomly chosen winter transport

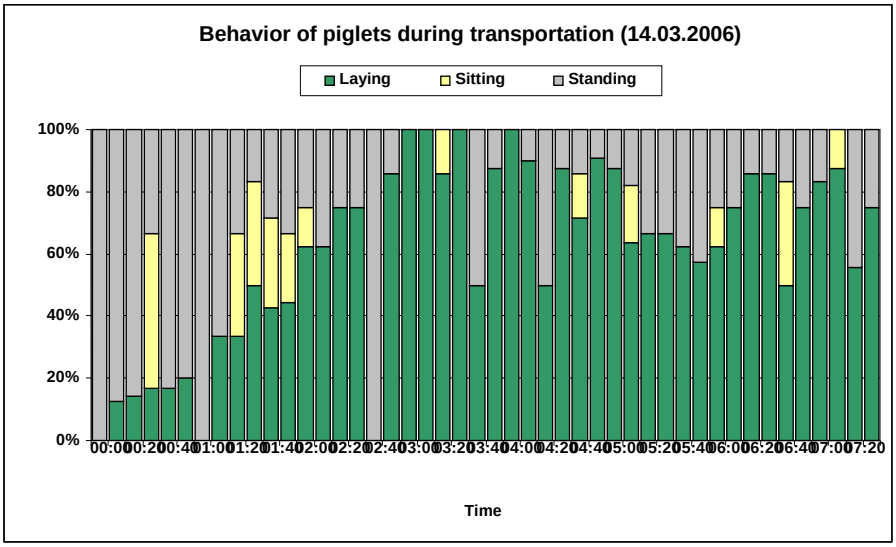
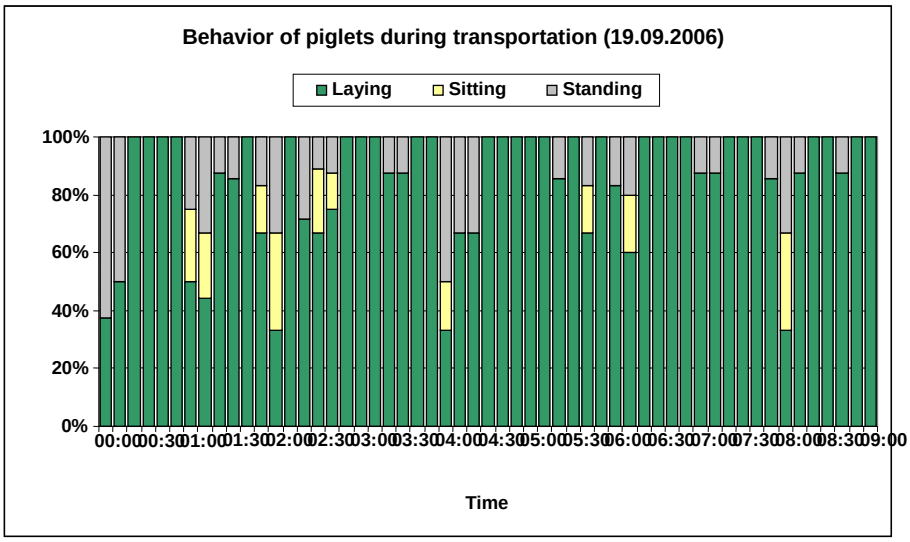


Figure 16 – Distribution of piglets lying down, sitting or standing during a randomly chosen summer transport.



Heart rate (HR) monitoring

There were no registrations of HR of piglets since no equipment was available that could have been used while at the same time still ensuring good animal welfare.

Veterinary conditions at loading

All animals were considered fit for transport, no pigs were rejected.

Veterinary conditions at offloading

See Attachment 6.

Slaughter pigs weighing approx. 100 kg

Levels of temperature (T), relative humidity (RH) and CO_2 for all transports of pigs

An overview covering all transports during summer is shown below in Figure 17 and for all transports in winter in Figure 18.

The figures shown in the columns to the left and right correspond to the 6th (left) and the 7th (right) September. Each deck represents the 3 compartments per tier.

Figure 17

06+07 09.06	Temperature, RH, CO2 per tier								
Deck	Fore carrier					Hanger			
Upper	T	RH	CO2	T out	RH out	T	RH	CO2	T out
ave	**23,0-18,3**	**78-69**	**1010-1080**	**22,2-17,5**	**80-73**	**23,5-18,7**	**74-69**	**1037-1085**	**23,2-20,5**
min	19,9-15,1	65-59	780-848	19,8-14,4	0-51	19,7-14,9	.6-20	780-893	19,3-17,8
max	25,6-20,4	96-87	2003-1658	24,6-22,8	99-99	25,8-20,8	98-99	2250-1778	25,5-22,7
Mid	T	RH				T	RH		
ave						**25,3-21,7**	**73-61**		
min						20,9-17,9	39-49		
max						31,0-26,3	95-95		
Lower	T	RH	CO2			T	RH	CO2	
ave	**24,1-19,4**	**73-65**	**998-1109**			**25,6-21,4**	**70-61**	**1039-1020**	
min	20,6-17,4	62-56	743-845			21,3-18,1	38-52	743-855	
max	27,0-21,6	82-85	1935-1688			30,1-25,0	92-91	1680-1350	

As seen, the variation between the two transports in summer is quite small, the average temperature varies between 4.7°C on the fore carrier and 3.4°C on the hanger.

The maximum temperature was 30.1°C; the highest level was registered on the lower tier of the hanger. The highest temperature on the fore carriage was 27.0°C, measured on the lower deck.

Relative humidity was lowest when temperatures were highest and vice versa

When the relative humidity was measure at 99% RH or another high figure (≥85%) this was normally once in a five minute period and normally very late in the day, round 7 to 8 pm. High RH in combination with temperatures above 24°C was seldom seen, and if so it lasted from 5 to 20 minutes and then the temperature normally decreased to 24°C or below, which is the LWSI index level of “safe/alert”. One measurement in a five minute period was in the LWSI area alert/danger and to danger/emergency. RH was in this case 90% and the temperature 30°C, so it can be discussed whether the EU legislation requires enough space for ventilation or defines space allowance (free space) sufficiently.

The combination with high temperatures and high RH occurred when the vehicle was moving. It can, however, be seen from the tachograph that the speed was quite slow, between 10 and 40 km/h.

The average temperatures on the individual tier on the fore carrier, on the upper, middle and lower deck compared with outdoor temperature showed a higher temperature deviation (highest deviation) from 0.8, 18.6 and 3.8°C respectively and the corresponding measures from the hanger was –1.8, 2.1 and 2.4°C.

The tier on the fore carrier is most likely influenced by the chassis (motor and transmission) and the hanger has temperatures very much like outdoor temperatures, and on the upper tier temperatures are even lower.

Highest temperatures were seen in the following compartments: F1U F1L and H1U, H2M and H2L, that is all the compartments closest to the driver’s cabin as far as the fore carrier is concerned or in the vehicle centre for the hanger. Deviation in temperature between the compartments was small, varying between 0 and 1.2°C.

The CO_2 level was in general low indicating good ventilation in all compartments. Highest level was normally seen on the lower front compartment (F1L/F3U) and in the lower back compartment (H1L), where it is also normal that the ventilation is poorest.

The figures shown in the columns to the left and right correspond to the days 20th (left) and the 23rd (right). Each deck represents the 3 compartments per tier.

Figure 18

20+23 02.06	Temperature, RH, CO2 per tier								
Deck	Fore carrier					Hanger			
Upper	T	RH	CO2	T out	RH out	T	RH	CO2	T out
ave	**7,0-4,8**	**84-87**	**955-928**	**error-1,5**	**error-81**	**9,2-7,9**	**71-64**	**859-939**	**5,9-error**
min	3,7-2,2	62-73	480-698	error- -0,1	error-0	6,1-3,9	0-0	533-713	4,3-error
max	12,5-11,2	99-99	2100-1275	error-6,0	error-99	17,0-13,8	99-99	1675-1515	7,2-error
Mid	T	RH				T	RH		
ave						**17,5-16,5**	**54-59**		
min						12,2-9,2	18-12		
max						25,9-20,6	96-92		
Lower	T	RH	CO2			T	RH	CO2	
ave	**11,2-10,6**	**67-71**	**1030-949**			**17,1-14,8**	**49-51**	**1037-1193**	
min	7,0-7,8	51-35	615-750			12,9-7,2	24-0	495-840	
max	16,4-17,8	92-99	1980-1388			23,2-18,4	99-94	1808-1868	

The variation between the two transports in winter is quite small. The average temperature varies from 0.6 to 2.2°C on the fore carrier. On the hanger a similar picture is shown, with a variation between 1.3 and 1.0°C and 2.3°C on the lower deck.

The minimum temperature was 2.2 and 3.9°C; the lowest level was registered on the upper tier on the fore carrier and on the upper tier on the hanger.
High RH in combination with temperatures above 24°C was not seen and all transports were in accordance with the LWSI index level “safe/alert”.

The average temperatures in the individual tiers on the fore carrier, comprising upper and lower decks, compared to outdoor temperatures showed a higher temperature (lowest deviation) from 3.3 and 9.1°C respectively and the corresponding temperatures measured on the hanger, including a middle deck, was 3.3, 11.6 and 11.2°C.

The lowest temperatures measured on front carrier was 1.7°C on upper tier, room F3U and on the hanger room H1U/H3U, 3.7°C, for a rather short time period of 20 and 5 minutes respectively, meaning that temperatures between 4-5°C is not uncommon, measured with the equipment mounted above the pigs. The temperature among the pigs is then 3-5°C higher and round 7-10°C.
Periods with lower temperatures were seen for up to approx. 90 minutes; pigs are, however, used to the climatic conditions and can cope with these temperatures. An investigation in Sweden showed that the pigs were not compromised at even lower temperatures and for longer transports of up to 6 hours, Christensen, L. and Jonsson, K. (2007) Optimization of transport conditions in relation to transport mortality. To be published.
The Swedish research showed that the pigs cope with national climatic conditions to some extent. The mortality rate was 0 when driving in temperature levels between +5 and –10°C in the compartments, and the statutory official veterinarian control at abattoirs at offloading (all pigs are checked when being

offloaded) had no comments that the low temperature depreciates animal welfare.

Temperature

The temperatures measured in the different compartments of the vehicle show that the measuring points in the front compartments on the lower tier and in the rear compartments on the upper tier of the fore-carriage as well as of the hanger are in general representative of all measuring points on the vehicle. Course for temperature measuring points are shown in Attachment 10.

Transports of slaughter pigs give a clear picture of where the temperature has been highest and lowest for the longest time during the transports. Looking at the fore-carriage, the highest temperature for the longest time was shown in the compartment closest to the driver's cabin on the lower deck. On the hanger, the highest temperature sequences were found on the middle deck in one of the two rooms in front. The lowest temperature sequences over time were found on the upper deck in the rear compartments on the fore-carriage as well as on the hanger. It was the same scenario on winter as well as on summer transports.

Registration of compartments where the highest and lowest level of temperature occurred for the longest period of time is shown as percentage of transport time, see Figure 19 and 20.

Figure 19 *- Summer transports - Temperature*

	Fore-carriage			Hanger		
	High: 0 % Low: 1 %	High: 0 % Low: 25 %	High: 0 % **Low: 74 %**	High: 0 % Low: 13 %	High: 0 % Low: 16 %	High: 0 % **Low: 69 %**
	High: 98% Low: 0 %	High: 0 % Low: 0 %	High: 2 % Low: 0 %	High: 21 % Low: 0 %	**High: 74%** Low: 0 %	High: 3 % Low: 2 %
				High: 3 % Low: 0 %	High: 1 % Low: 0 %	HIgh: 6 % Low: 0 %

Figure 20 *– Winter transports - Temperature*

	Fore-carriage			Hanger		
	High: 0 % Low: 0 %	High: 0 % Low: 13 %	High: 0 % **Low: 88 %**	High: 0 % Low: 19 %	High: 0 % Low: 7 %	High: 0 % **Low: 74 %**
	High: 82% Low: 0 %	High: 13 % Low: 0 %	High: 5 % Low: 0 %	**High: 57 %** Low: 0 %	High: 26% Low: 0 %	High: 1 % Low: 0 %
				High: 16 % Low: 0 %	High: 0 % Low: 0 %	High: 2 % Low: 1 %

Relative Humidity (RH)

RH measured in the different compartments of the vehicle show that the measuring points in the front compartments on the lower tier and in the rear compartments on the upper tier of the fore-carriage as well as of the hanger are in general representative of all measuring points on the vehicle. Course for RH measuring points are shown in Attachment 9.

The highest level of RH was found on the upper decks on the fore-carriage as well as on the hanger, mainly in the rear compartments. Lowest levels measured were found in the front compartments on the lower deck of the fore-carriage. On the hanger the lowest levels were distributed over the lower deck, and on one occasion on the middle deck in the middle compartment.

Registration of compartments where the highest and lowest level of RH occurred for the longest period of time is shown as percentage of transport time, see Figures 21 and 22.

Figure 21 *– Summer transport - RH*

Fore-carriage

High: 4% Min. RH: 1 %	**High:92%** Min. RH: 25%	High: 6% Min. RH: 4 %
Max. RH: 1% **Min. RH: 91%**	Max. RH: 0% Min. RH: 4%	Max. RH: 0% Min. RH: 5%

Hanger

High: 6% Min. RH: 3%	High:24% Min. RH: 1%	**Max. RH:68%** Min. RH: 0%
Max. RH: 1% Min. RH: 5%	Max. RH: 3% **Min. RH: 42%**	Max. RH: 2% Min. RH: 2%
Max. RH: 3% Min. RH: 8%	Max. RH: 0% Min. RH: 6%	Max. RH: 0 % Min. RH: 39%

Figure 22 *– Winter transport - RH*

Fore-carriage

High: 20 % Low: 0 %	High: 47% low: 0%	**High: 48%** Low: 1 %
High: 1% **Low: 94%**	High: 3% Low: 2%	High: 1% Low: 3%

Hanger

High: 25% Low: 1%	High:24% Low. RH: 1%	**High: 59%** Low. RH: 4%
High: 2% Low: 6%	High: 2% Low: 10%	High: 10% Low: 1%
High: 1% Low: 32%	High: 1% Low: 16%	High: 1 % **Low: 35%**

CO_2-level

The Danish Working Environment Service allows levels not higher than 5000 ppm and with reference to housing conditions a limit of 3000 ppm has been established. During transports the CO_2 level never got beyond 2830 ppm. Course for CO_2 measuring, see Attachment 16.

CO_2 measurements showed that the highest levels were measured in the rear rooms of the fore-carriage and in the front rooms of the hanger. Lowest occurrence was found in the front rooms of the fore-carriage and in the rear rooms of the hanger. Winter and summer transports were showing the same results.

Registration of compartments where the highest and lowest level of CO_2 occurred for the longest period of time is shown as percentage of transport time, see Figures 23 and 24.

Figure 23 *– Summer transports – CO_2-level*

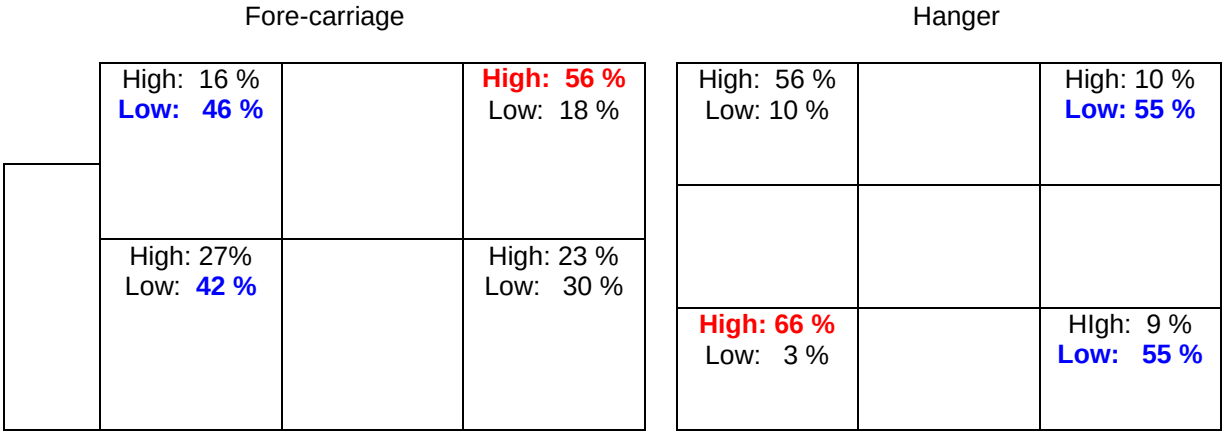
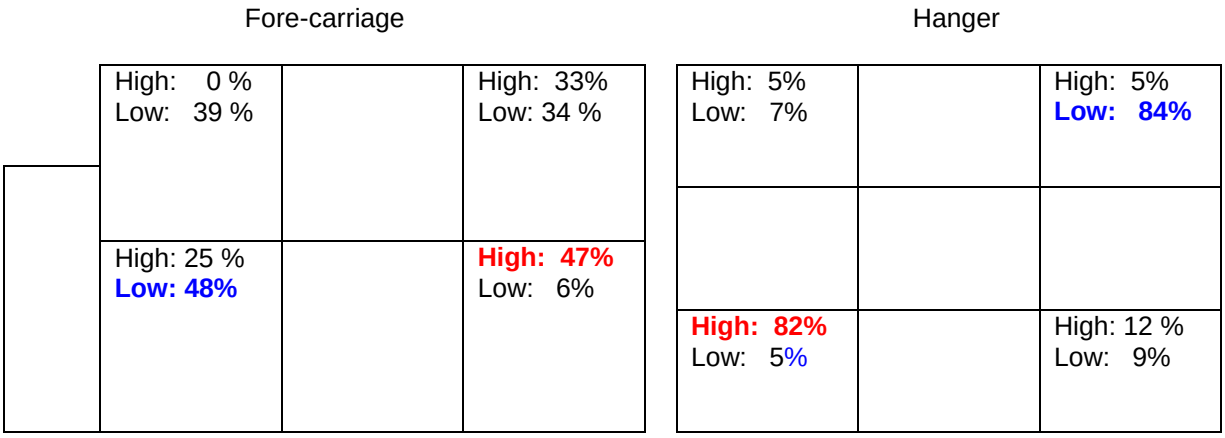


Figure 24 *– Winter transports – CO_2-level*



Animal behaviour

No major differences were found in relation to activity level among the animals, irrespective of season. The activity rate during transports in winter and in summer was steadily declining from start to end of transport. After one hour of transport some 44% of the pigs were still active, after 3 hours of transport the activity level had dropped to approx. 10%. After 7 hours of transport there were barely any sign of activity among the pigs.

No incidents of aggression nor were fights of short or long duration observed during the transport.

During the transports the majority of pigs were lying together in a group such that approx. 25-30% of the floor was free. The area was used by very few of the pigs for activities and exploration.

Video recordings showed that the pigs show little attempt for exploration/ activity during the transport. Occasionally an animal gets on its feet and move around in the group of resting animals for a minute or so, then it lies down again. Other animals use the free space for activity. Animals covered by other animals were observed, but as long as they had their head or snout uncovered there were no reactions.

In approx. 20% of the cases when a pig is standing, it is when the vehicle is at a stand-still. The first long stop was after transport for approx. 3 hours and 10 minutes. The second long stop was after transport for 5 hours and 30 minutes. Few of the pigs got on their feet at a later time without the vehicle stopping.

Whether the pigs choose to stand can relate to the vehicle making a stop or it is conditioned on the circadian rhythm which was not disclosed in this investigation.

The number of pigs lying down, sitting or standing during transport is shown in Table 12 below. The number of pigs standing compare to time of transport is shown in Table 13.

Table 12 – Distribution (%) of pigs lying down, sitting or standing

%	Lying down	Sitting	Standing
Winter	84.0	5.0	11.0
Summer	79.1	11.2	9.7

Table 13 – Distribution (%) of pigs standing compared to time of transport

Hours	1	3	5	7	9
Winter	44.0	18.4	3.7	4.7	0.0
Summer	17.1	15.4	10.4	6.8	0.9

Figures 25 and 26 illustrate the corresponding distribution for 2 randomly chosen transports carried out during winter and summer period.

Figure 25

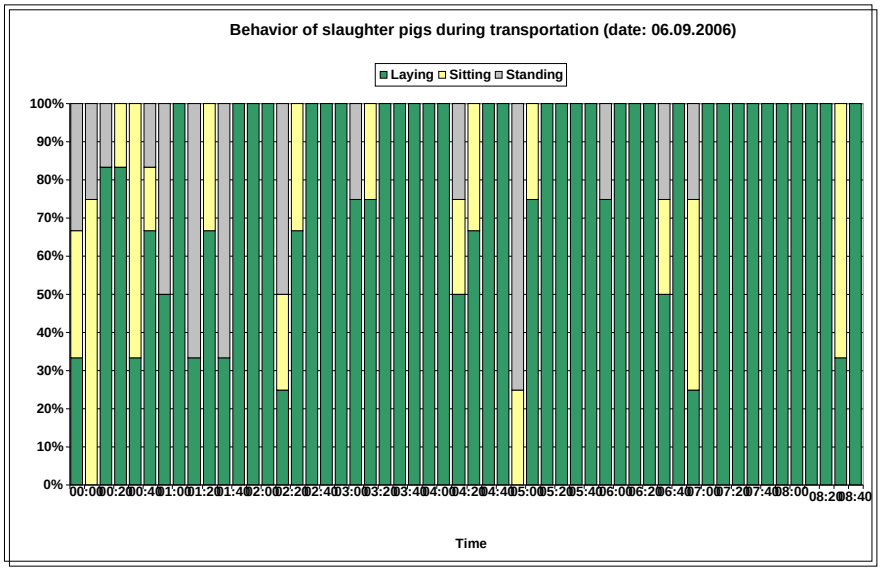


Figure 26

Heart rate (HR) monitoring

Registration of HR has normally only been done on short transports and during lairage at the abattoir. In connection with long transports it has only been possible to make a few registrations over longer periods. Registration of HR in this investigation may therefore only be considered as guidance.
For registrations of all HR monitored for slaughter pigs, see Attachments 18 to 21.

The HR level has been reasonably steady with an average of 112 beats per minute in the summer registrations and 103 in the winter registrations. Irrespective of time of year the highest HR measured was 220 beats per minute. Minimum values are difficult to interpret as there have been periodic drop-outs during the measuring periods. Registrations show, however, values between 83 heart beats per minute for summer transports and 67 heart beats for winter transports.

The registrations do thus not deviate from what is normal for slaughter pigs being transported.

Table 14 – HR for slaughter pigs – summer

Compartment	Mean	Max.	Min.
F1U	111	225	95
H1U	117	219	77
H2U	104	233	74
H1L	99	216	81
F3L	136	225	99
F1L	108	228	77
H3L	106	220	80
Mean total	**112**	**224**	**83**

Table 15 – HR slaughter pigs – winter

Compartment	Mean	Max.	Min.
F2U	95	205	58
F3L	106	237	54
H1U	96	225	55
H2U	96	226	57
H1L	97	213	88
H3L	96	204	58
F1L	112	227	79
F2L	123	234	89
Mean total	**103**	**222**	**67**

Veterinary conditions loading

All animals were considered fit for transport, therefore no rejections in connection with loading.

Veterinary conditions offloading

See Attachment 6.

Sows weighing >130 kg

Levels of temperature (T), relative humidity (RH) and CO_2 for all transports of sows

An overview covering all transports during summer is shown below in Figure 27 and for all transports in winter in Figure 28.

The figures shown in the columns to the left and right correspond to the 11th (left) and 12th (right) September. Each deck represents the 3 compartments per tier.

Figure 27

11+12 09.06	Temperature, RH, CO2 per tier								
Deck	Fore carrier					H anger			
Upper	T	RH	CO2	T out	RH out	T	RH	CO2	T out
ave	**22,4-20,1**	**70-76**	**1023-1386**	**21,3-19,3**	**70-79**	**22,7-20,9**	**71-75**	**1063-1298**	**23,3-21,4**
min	18,3-16,7	50-60	915-1005	15,7-13,9	46-60	18,3-17,5	53-61	915-1020	18,5-18,1
max	28,1-24,6	95-91	1103-2198	30,3-24,7	99-99	28,1-24,8	99-97	1478-2310	28,7-26,2
Lower	T	RH	CO2			T	RH	CO2	
ave	**23,4-21,3**	**65-71**	**1083-1317**			**24,1-22,3**	**65-73**	**1005-1221**	
min	19,7-18,0	50-59	930-1013			20,7-19,5	51-60	908-1028	
max	27,7-25,4	81-91	2543-2550			27,5-25,7	89-99	1530-2400	

The variation between the two transports in summer is only small.
The average temperature varies 2.3°C on the fore carrier and 1.8°C on the hanger.

The maximum temperature was 28.1°C; the highest level was seen on the upper tier, on the fore carrier as well as on the hanger.

Relative humidity was normally lowest when the temperatures were highest and vice versa.

Under the item: *Mortality, explanations* plus Attachment 7, the correlation between high temperatures and relative humidity has been shown and discussed and no further will be added to this chapter.

The average temperatures in the individual tiers on the fore carrier, on upper and lower decks, compared to outdoor temperatures, showed a higher temperature (highest deviation) from 1.1 and 2.1°C respectively, and the corresponding measures from the hanger was –0.5 and 0.9°C respectively. The tier on the fore carrier is most likely influenced by the chassis (motor and transmission), and the hanger had temperatures very much like the outdoor temperature and for the upper tier the temperature was even lower.

The CO_2 level was in general low, indicating good ventilation in the compartments. Highest level was found on the lower front compartment F1L and the rear compartment F3L, where normally the ventilation is also poorest. For a short while the level increased 3000 ppm and was 3360 and 3090 respectively, however, not on the same transport.

The figures shown in the columns to the left and right correspond to the 21st (left) and the 22nd (right) February. Each deck represents the 3 compartments per tier.

Figure 28

21+22.02.06	Temperature, RH, CO2 per tier								
Deck	Fore carrier					Hanger			
Upper	T	RH	CO2	T out	RH out	T	RH	CO2	T out
ave	**5,5-5,8**	**77-73**	**776-870**	**1,6-1,0**	**83-71**	**5,4-6,4**	**77-75**	**810-983**	**4,4-2,6**
min	1,7-3,0	66-60	638-705	0,2- -0,7	71-45	2,6-3,3	69-62	523-705	2,8-1,4
max	9,0-14,5	99-99	1133-1440	9,2-8,7	92-82	7,3-10,8	98-99	1320-1598	5,9-4,8
Lower	T	RH	CO2			T	RH	CO2	
ave	**5,9-6,7**	**74-63**	**932-1089**			**8,3-8,4**	**71-72**	**905-1092**	
min	4,2-4,8	61-54	683-818			2,3-1,2	61-57	630-713	
max	11,3-12,4	93-90	1478-2003			10,6-11,3	99-99	1598-2715	

The variation between the two transports in winter is only small.
The average temperature varies from 0.3 to 0.8°C on the fore carrier. On the hanger a similar picture is shown, with a variation from 0.1 to 1.0 °C.

The minimum temperature was 1.2 and 1.7°C, and lowest level was seen on the upper tier on the fore carrier and one the lower tier on the hanger.

High RH in combination with temperatures above 24°C was not seen, and all transports where according to the LWSI index level "safe/alert".

The average temperatures on the individual tier on the fore carrier, on the upper and lower decks, and compared to outdoor temperatures showed a higher temperature (lowest deviation) from 3.9 and 4.8°C respectively and the corresponding measurements of temperature on the hanger was 1.0 and 3.8°C.

The lowest temperatures measured on the front carrier was 1.1°C on the upper tier, room F2U, and on the hanger, room H1U, 2.3°C, both temperatures measured for 5 and 2 hours respectively. Temperatures between 4-5°C is thus not uncommon, measured with the equipment mounted above the pigs. The temperature among the pigs is then 3-5°C higher and round 7-10°C. An investigation in Sweden showed that the pigs were not compromised at even lower temperatures and for longer transports of up to 6 hours, Christensen, L. and Jonsson, K. (2007) Optimization of transport conditions in relation to transport mortality. To be published.
The Swedish research showed that the pigs cope with national climatic conditions to some extent. The mortality rate was 0 when driving in temperature levels between +5 and –10°C in the compartments, and the statutory official veterinarian control at abattoirs at offloading (all pigs are checked when being offloaded) had no comments that the low temperature depreciates animal welfare.

The CO_2 level was in general low, indicating good ventilation in the compartments. Highest level was normally seen in compartment H3L on the hanger.

For a complete overview of temperatures, RH and CO_2 on the individual transport and in each compartment, please refer Attachment 8.

Temperature

The temperatures measured in the different compartments of the vehicle show that the measuring points in the front compartments on the lower tier and in the rear compartments on the upper tier of the fore-carriage as well as of the hanger are in general representative of all measuring points on the vehicle.

Course for temperature measuring, see Attachment 9.

Transports of sows give a clear picture of where the temperature was highest and lowest for the longest time during the transports. Looking at the fore-carriage as well as the hanger, the highest occurring temperature measured for the longest time was in the front rooms on the lower deck. The lowest temperature sequences over time were found on the upper deck in the rear compartments on the fore-carriage as well as on the hanger. It was the same scenario irrespective of season.

Registration of compartments where the highest and lowest level of temperature occurred for the longest period of time is shown as percentage of transport time, see Figure 29 and 30.

Figure 29 *– Summer transports – Temperature*

	Fore-carriage			Hanger		
	High: 36% Low: 33%	High: 0% Low: 26 %	High: 0% **Low: 70%**	High: 0% Low: 6%	High: 0% Low: 5%	High: 1% **Low: 88%**
	High: 97% Low: 0 %	High: 0% Low: 0%	High: 0% Low: 4%	**High: 94%** Low: 0%	High: 3% Low: 1%	High: 1% Low: 0%

Figure 30 *– Winter transports – Temperature*

	Fore-carriage			Hanger		
	High: 22% Low: 0%	High: 3% Low: 1%	High: 0% **Low: 64%**	High: 0% Low: 3%	High: 2% Low: 0%	High: 1% **Low: 91%**
	High: 75% Low: 3%	High: 0% Low: 0%	High: 0% Low: 31%	**High: 97%** Low: 1%	High: 0% Low: 0%	High: 0% Low: 4%

Relative Humidity (RH)

RH measured in the different compartments of the vehicle show that the measuring points in the front compartments on the lower tier and in the rear compartments on the upper tier of the fore-carriage as well as of the hanger are in general representative of all measuring points on the vehicle. Course for RH measuring, see Attachment 12.

The highest level of RH was found on the upper decks, in general in the rear compartments of the fore-carriage as well as on the hanger. The lowest levels measured were found in the front compartments on the lower deck of the fore-carriage as well as on the hanger.

Registration of compartments where the highest and lowest level of RH occurred for the longest period of time is shown as percentage of transport time, see Figures 31 and 32.

Figure 31 *– Summer transports - RH*

	Fore-carriage			Hanger		
	High: 67% Low: 50%	High: 64% Low: 0%	**High: 67%** Low: 0%	High: 3% Low: 1%	**High: 55 %** Low: 0%	High: 34% Low: 4%
	High: 1% **Low: 89%**	High: 1% Low: 4%	High: 3% Low: 6%	High: 1% **Low: 53%**	High: 5% Low: 12%	High: 2% Low: 34%

Figure 32 *– Winter transports - RH*

	Fore-carriage			Hanger		
	High: 16% Low: 3%	High: 8% Low: 0%	**High: 67%** Low: 0%	High: 7% Low: 2%	High: 12% Low: 2%	High: **40%** Low: 5%
	High: 0% **Low: 88%**	High: 1% Low: 3%	High: 13% Low: 6%	High: 2% **Low: 80%**	High: 1% Low: 15%	**High: 42%** Low: 2%

CO_2-level

The Danish Working Environment Service allows levels not higher than 5000 ppm and with reference to housing conditions a limit of 3000 ppm has been established. During transports the CO_2 level never got beyond 3400 ppm. Course for CO_2 measuring, see Attachment 15.

The CO_2 measurements show a difference between summer and winter transports. During summer, the highest temperatures were found on the upper deck in the front compartment of the fore-carriage and in the rear compartment on the hanger. During winter the highest levels were measured on the lower deck, in the rear of the fore-carriage and in the front compartments of the hanger.

Lowest CO_2 levels were all found on the upper deck of the fore-carriage and the hanger. During summer transports in front compartments of fore-carriage and in the rear of hanger and exactly the opposite during winter transports.

Registration of compartments where the highest and lowest level of CO_2 occurred for the longest period of time is shown as percentage of transport time in, see Figure 33 and 34.

Figure 33 *– Summer transports – CO_2-level*

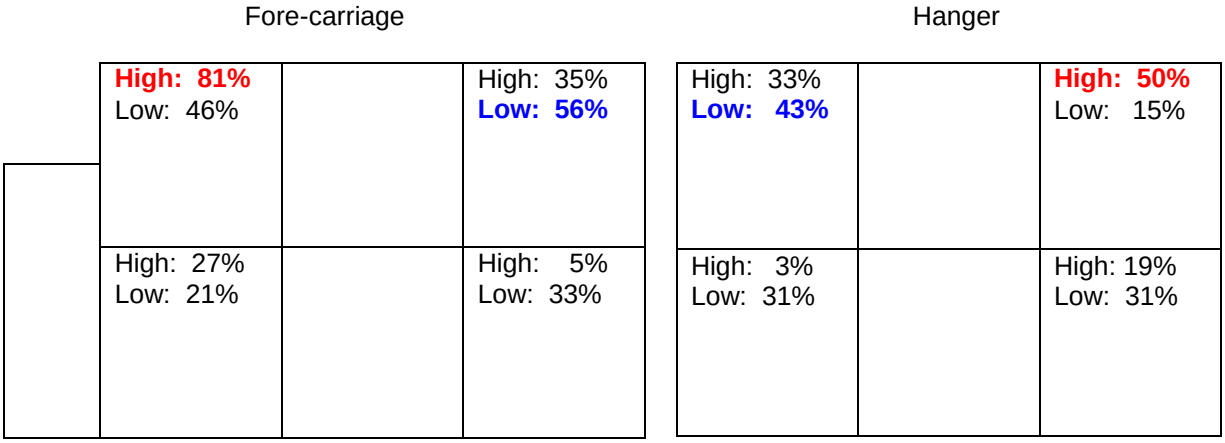
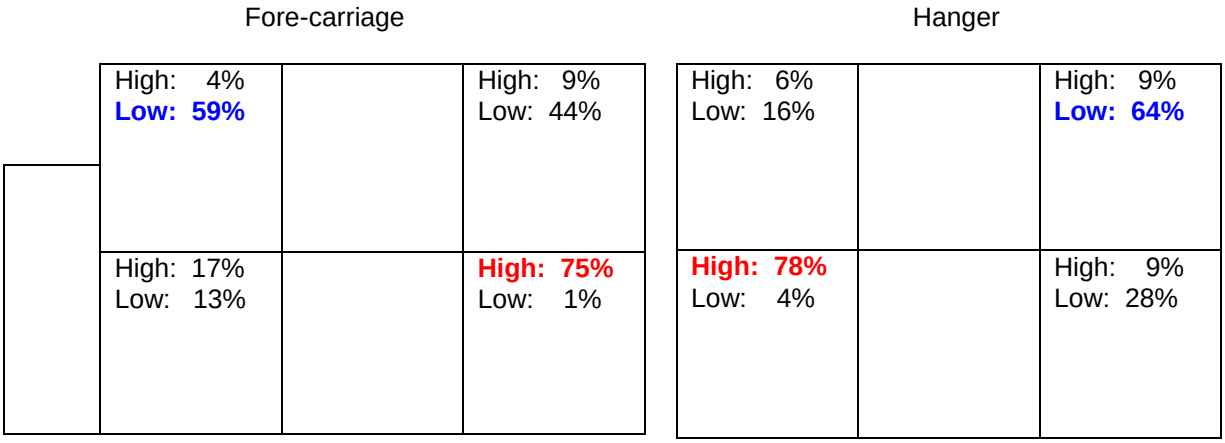


Figure 25 *– Winter transports – CO_2-level*



Animal behaviour

Differences were registered with respect to activity and in relation to time of the year. The activity among sows on transports during the summer showed a steadily decreasing activity level from start of transport to end of transport. Transports during the winter had varying activity level during the first 5 hours of transport. Then the activity dropped and the level varied somewhat during the remainder of the transport.

Long fights among the sows were observed neither on winter nor on summer transports. Periodic aggression between the sows were, however, observed during winter transports; typically in connection with sows getting up on their feet or when they attempted to lie down. Aggressions observed were evenly distributed over the entire transport, lasted less than 10 seconds and were in the nature of demonstration or a short fight. The number of aggressions was very low, and only on one occasion was it in connection with a stop of the transport. No registration of any kind of aggression during summer transports.

During the transports the majority of sows were lying down in groups such that approx. 20-30% of the floor was free. This area was used by a few sows for activity or exploration.

Video recordings show that a few sows show an attempt for exploration/ activity in periods of up to 3 hours, and then they lie down.

4-6 hours after having been loaded onto the vehicle some sows were observed getting on their feet and move around among the other resting sows. Other sows move around for a short while and then lie down again with the other sows after a period of 1 to 10 minutes. Animals covered by other animals were observed, but as long as they had their head or snout

uncovered there were no reactions.

No registrations have been made of a possible relation between number of sows standing whether the transport vehicle was at a stand-still or it was running.

The number of sows lying down, sitting or standing during transport is shown in Table 16 below. The number of sows standing compared to time of transport is shown in Table 17.

Table 16 – Distribution (%) of sows lying down, sitting or standing

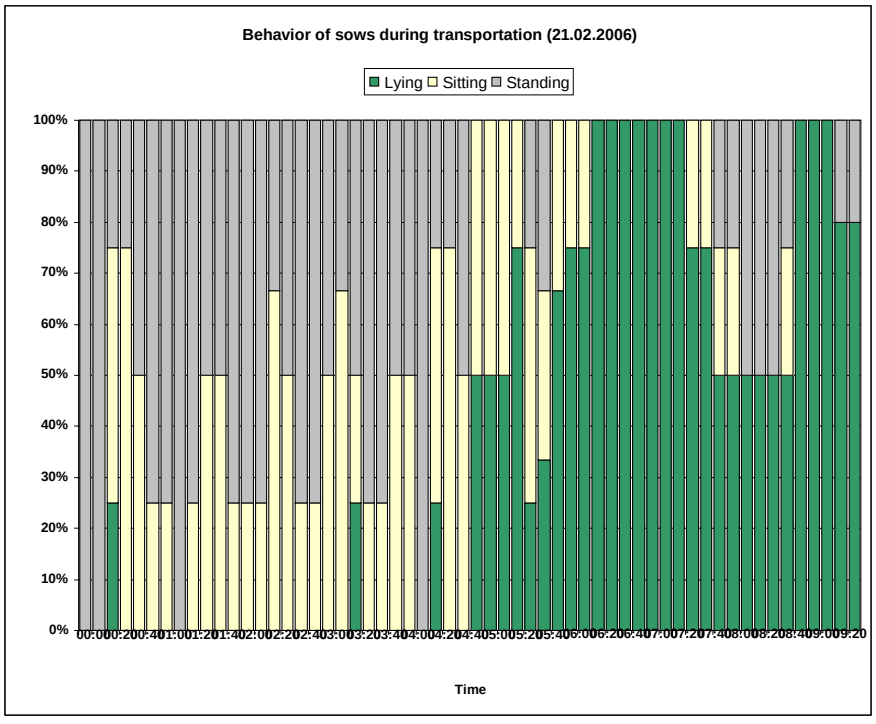
	Lying down	**Sitting**	**Standing**
Winter	50.8	20.9	28.3
Summer	78.0	6.9	15.1

Table 17 – Distribution (%) of sows standing compared to time of transport

Hours	1	3	5	7	9
Winter	58.3	68.6	43.5	4.3	18.8
Summer	51.9	30	14.8	5.4	5.0

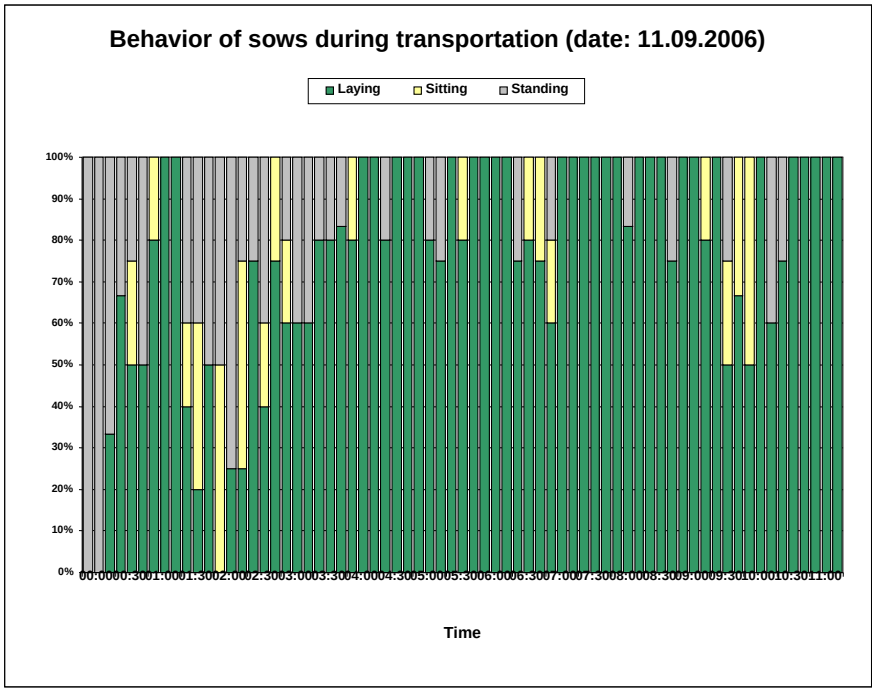
Figures 26 and 27 illustrate the corresponding distribution for 2 randomly chosen transports carried out during winter and summer periods.

Figure 35



One observation represents 6 sub observations distributed over 60 seconds.

Figure 36



One observation represents 6 sub observations distributed over 60 seconds.

Heart rate (HR) monitoring

We have only little knowledge of measurements of HR on sows during transport. In connection with long transports it has only been possible to make a few registrations over longer periods. Registration of HR in this investigation may therefore only be considered as guidance.

The HR level has been reasonably steady with an average of 120 beats per minute irrespective of the season. The highest HR measured showed a difference between summer and winter. The max. HR in summer was 201 beats per minute, whereas the max. HR in winter was 231 beats per minute. The minimum values were difficult to interpret as periodic drop-outs were experienced during the measuring periods. Registrations showed values of 79 and 70 per minute in summer and winter transports respectively.

For registration of all HR monitored for sows, see Attachments 22 – 25.

Registrations of HR for sows are in general a little higher than for slaughter pigs.

Table 18 – HR – sows, summer

Compartment	Average	Max.	Min.
F3L	97	206	56
H2L	157	226	93
H1U	136	223	94
H3U	89	131	66
H3L	139	217	87
Mean total	**124**	**201**	**79**

Table 19 – HR, sows, winter

Compartment	Average	Max.	Min.
F1U	85	213	63
F2U	188	295	64
F1L	121	228	63
F2L	96	206	58
F3L	112	226	74
H3U	115	222	71
H1L	130	227	98
Mean Total	**121**	**231**	**70**

Veterinary conditions - loading

No sows were rejected by the veterinary inspection in connection with loading.

Veterinary conditions - offloading

See Attachment 6.

Conclusions

Temperature, relative humidity and CO_2 measurements

Registrations of temperature and relative humidity measured in the different compartments on the fore-carriage as well as on the hanger give a clear pattern of where to install measuring equipment for registration of temperature in accordance with the EU legislation. Using the front compartments on lower tiers and the rear compartments on upper tiers for registration of temperatures will give a good picture of temperature levels in the rest of the compartments on the vehicle. The measuring points can be used for observing the registrations required by EU legislation.

The level of relative humidity in connection with temperature levels gives reason for awareness when the vehicle is standing still for a long period of time, say approx. 30 minutes. It seems that if the limits, 5 – 30°C ±5°C as stated in the EU legislation are observed, pigs should not suffer any harm if the vehicle has a mechanical ventilation system and the drivers have been instructed in how to use the system correctly.
There is negative combinations of temperature and relative huidity where forced ventilation can avoid this situation to some extent and especially when the temperature is above, or in time before the reach 24°C.

No CO_2 measurements have gone above 3360 ppm during the investigation. It can be discussed why there should be a difference in levels between humans and animals, but as neither of these levels has been exceeded during the investigations there seems to be no need for making CO_2 measurements on vehicles transporting livestock compulsory.

The ventilation openings in the vehicles used for the transports in this investigation have been sufficient to ensure good micro-climatic conditions on the vehicle. To have the possibility to control the environment on the vehicle by means of mechanical ventilation and sprinkling of the pigs in warm weather can only contribute to improving the conditions for the animals even further.

Behaviour

During transport, the pigs irrespective of size have preferred to lie down in groups making a free space in the compartments of 20-30 % of the actual floor space. There has been a normal level of activity and as seen in previous transport investigations a very low frequency of aggression and fights.

Heart rate monitoring

Heart rate registered for slaughter pigs and sows has not been as good as we could have wished. It has only been possible to obtain some sequences that stretched out over the full duration of the transport. Figures have shown that the heart rate levels for slaughter pigs do not differ from what has been found in other previous investigations and they also correspond to the level at

housing. Level of heart rate for sows is a little higher than seen for slaughter pigs.

Veterinary conditions

Two transports had DOA pigs (sows), both correspond to transports with major stops or very slow driving during the transport and in combination with rather high RH and high temperature.

Injuries were seen, but they do not correspond to the level of fighting etc. observed via cameras in the vehicle compartments.

Driving with pigs in temperatures below 5^{o}C has not been seen to influence the pigs in a negative way.

Drivers

There has been a lack of proper information, how to use the vehicle when driving, a set of guidelines, but this has been a possibility carrying through this project (see Final conclusion).
There must be information access on the vehicle, in the drivers cabin, informing about the temperatures in the compartments and how the driver must react to this information.

Final conclusion

Please refer page s4 and 5 of this report.

Participants

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Tierärtzliche Hochschule Hannover, Germany: Jörg Hartung, Harald Ulbricht

Haulier: Transport organisation: SamMark

References:

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Christensen L., and Barton Gade, P., (1995). Design of Experimental Vehicle for Transport of Pigs and some preliminary results of environmental measurements. Report No. 02.674 in the Danish Meat Research Institute AIR Project, AIR-3-CT 92-0262.

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Attachment 1

Days of transport of the individual categories

Category	**Transport – hours and minutes**	**Destination**	**Date of transport**
Approx. 25 kg (piglet)	8 hours 10 mins.	Germany	14.03.2006
Approx. 25 kg	8 hours 42 mins.	Germany	17.03.2006
Approx. 25 kg	7 hours 49 mins.	Germany	13.09.2006
Approx. 25 kg	9 hours 32 mins.	Germany	15.09.2006
Approx. 100 kg (slaughter pig)	12 hours 25 mins.	Germany	20.02.2006
Approx. 100 kg	9 hours 12 mins.	Germany	23.02.2006
Approx. 100 kg	7 hours 21 mins.	Germany	06.09.2006
Approx. 100 kg	8 hours 27 mins.	Germany	07.09.2006
>130 kg (ave. approx. 250 kg) (sow)	9 hours 36 mins.	Germany	21.02.2006
>130 kg (ave. approx. 250 kg)	7 hours 28 mins.	Germany	22.02.2006
>130 kg (ave. approx. 250 kg)	9 hours 54 mins.	Germany	11.09.2006
>130 kg (ave. approx. 250 kg)	9 hours 54 mins.	Germany	12.09.2006

Attachment 2

Pigs weighing approx. 25 kg

All measurements performed on the vehicle during transport

Signatures:

T = Temperature; RH = Relative humidity; CAM = Video sequence

Fore carriage (Drivers cab)	**Compartment No. 1**	**Compartment No. 2**	**Compartment No. 3**	
	T times 3 RH CO_2 CAM 1st tour	T times 3 RH	T times 3 RH CO_2 CAM 1st tour	Upper tier
	T RH	T RH	T RH	Middle tier
	T times 3 RH CO_2 CAM 2nd tour	T times 3 RH	T times 3 RH CO_2 CAM 2nd tour	Lower tier

Hanger (Drivers cab)	**Compartment No. 1**	**Compartment No. 2**	**Compartment No. 3**	
	T times 3 RH CO_2 CAM 1st tour	T times 3 RH	T times 3 RH CO_2 CAM 1st tour	Upper tier
	T RH	T RH	T RH	Middle tier
	T times 3 RH CO_2 CAM 2nd tour	T times 3 RH	T times 3 RH CO_2 CAM 2nd tour	Lower tier

Attachment 3

Pigs weighing approx. 100 kg

All measurements performed on the vehicle during transport

Signatures:

T = Temperature; RH = Relative humidity; CAM = Video sequence; HR = Heart rate

Fore carriage (Drivers cab)	**Compartment No. 1**	**Compartment No. 2**	**Compartment No. 3**	
	T times 3 RH CO_2 CAM 1st tour HR times 1	T times 3 RH HR times 1	T times 3 RH CO_2 CAM 1st tour HR times 2	Upper tier
	T times 3 RH CO_2 CAM 2nd tour HR times 2	T times 3 RH HR times 1	T times 3 RH CO_2 CAM 2nd tour HR times 2	Lower tier

Hanger (Drivers cab)	**Compartment No. 1**	**Compartment No. 2**	**Compartment No. 3**	
	T times 3 RH CO_2 CAM 1st tour HR times 2	T times 3 RH HR times 1	T times 3 RH CO_2 CAM 1st tour HR times 2	Upper tier
	T RH	T RH	T RH	Middle tier
	T times 3 RH CO_2 CAM 2nd tour HR times 2	T times 3 RH HR times 1	T times 3 RH CO_2 CAM 2nd tour HR times 2	Lower tier

Attachment 4

Sows weighing >130 kg (average 250 kg)

All measurements performed on the vehicle during transport

Signatures:

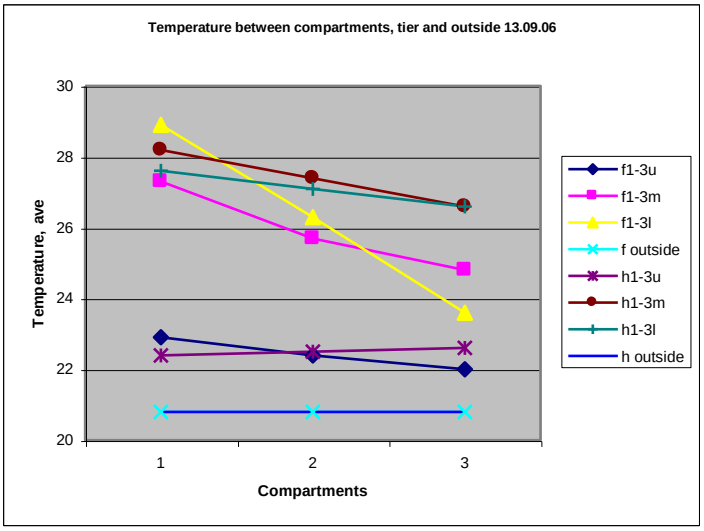
T = Temperature; RH = Relative humidity; CAM = Video sequence; HR = Heart rate

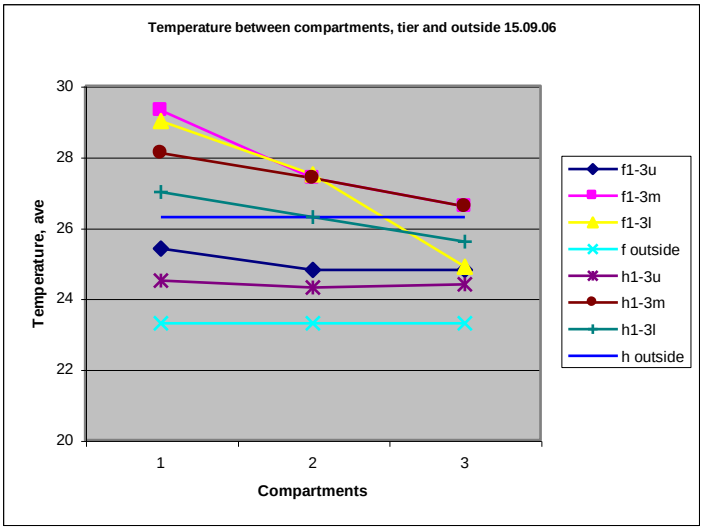
Fore carriage (Drivers cab)	**Compartment No. 1**	**Compartment No. 2**	**Compartment No. 3**	
	T times 3 RH CO_2 CAM 1st tour HR times 1	T times 3 RH HR times 1	T times 3 RH CO_2 CAM 1st tour HR times 2	Upper tier
	T times 3 RH CO_2 CAM 2nd tour HR times 2	T times 3 RH HR times 1	T times 3 RH CO_2 CAM 2nd tour HR times 2	Lower tier

Hanger (Drivers cab)	**Compartment No. 1**	**Compartment No. 2**	**Compartment No. 3**	
	T times 3 RH CO_2 CAM 1st tour HR times 1	T times 3 RH	T times 3 RH CO_2 CAM 1st tour HR times 2	Upper tier
	T times 3 RH CO_2 CAM 2nd tour HR times 2	T times 3 RH	T times 3 RH CO_2 CAM 2nd tour HR times 2	Lower tier

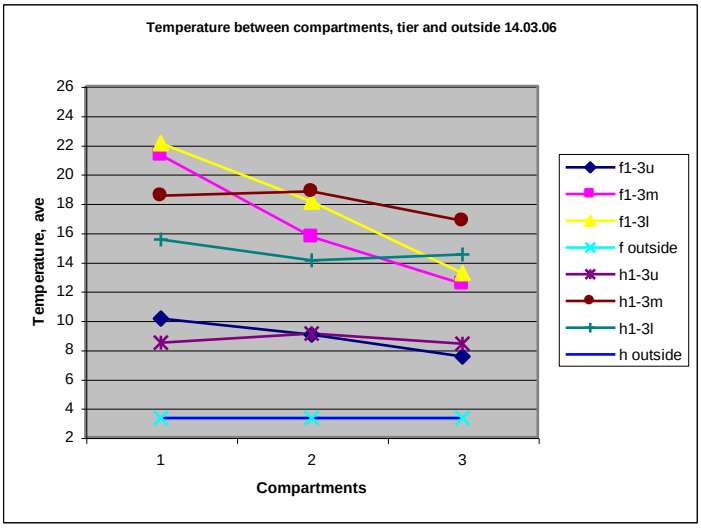
Attachment 5

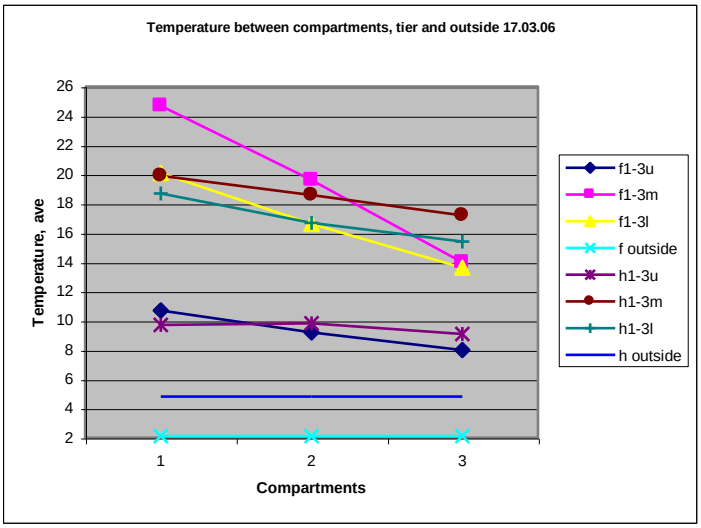
Piglets – Temperatures, correlation between fore carrier, tier, compartments and outdoor, summer



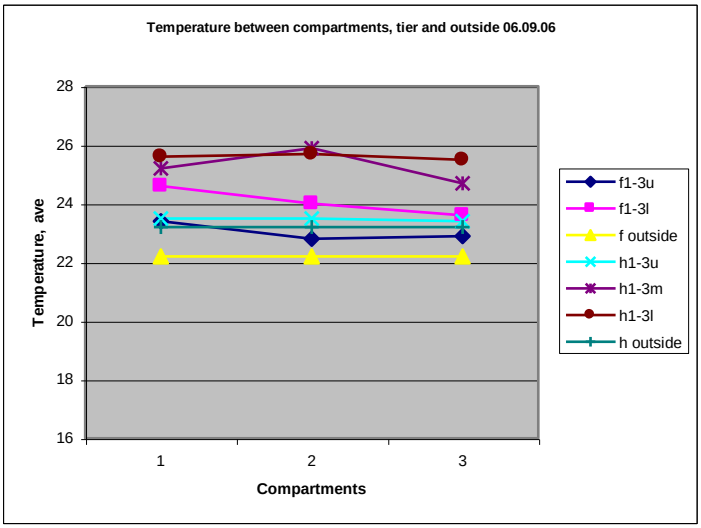


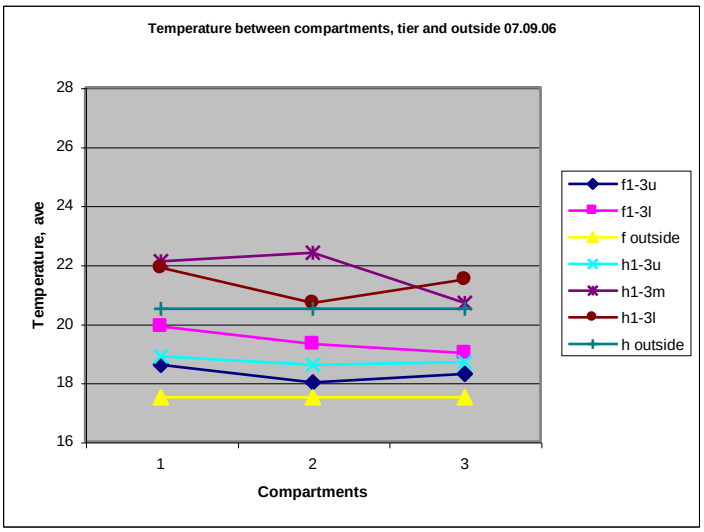
Piglets – Temperatures, correlation between fore carrier, tier, compartments and outdoor, winter



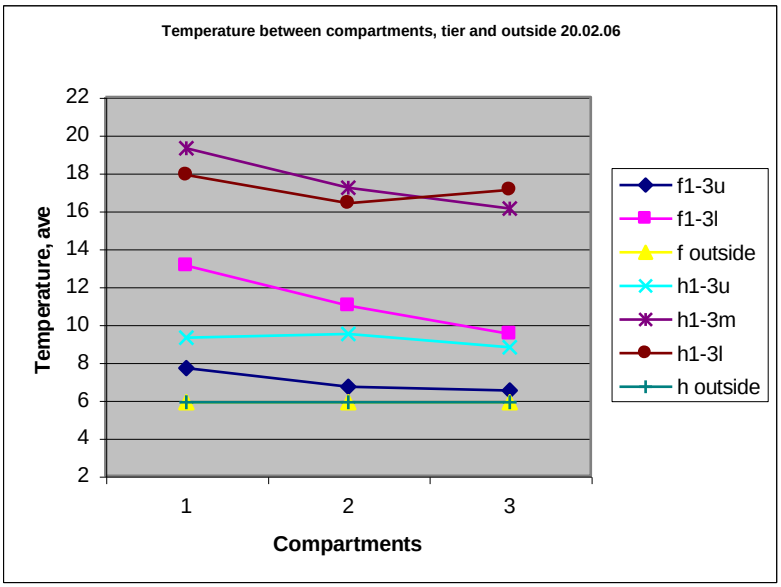


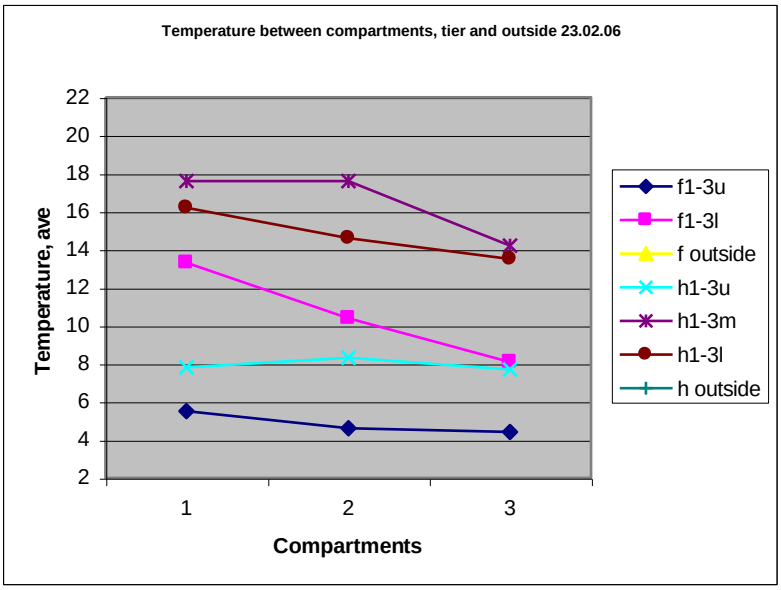
Slaughter pigs – Temperatures, correlation between fore carrier, tier, compartments and outdoor, summer



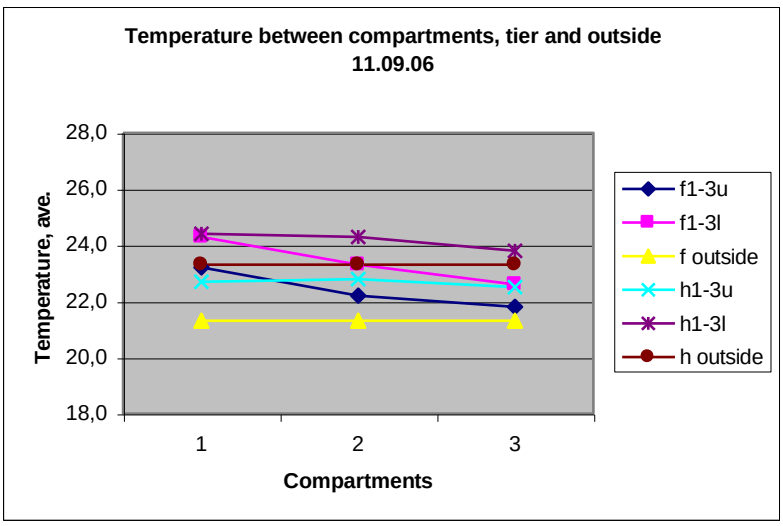


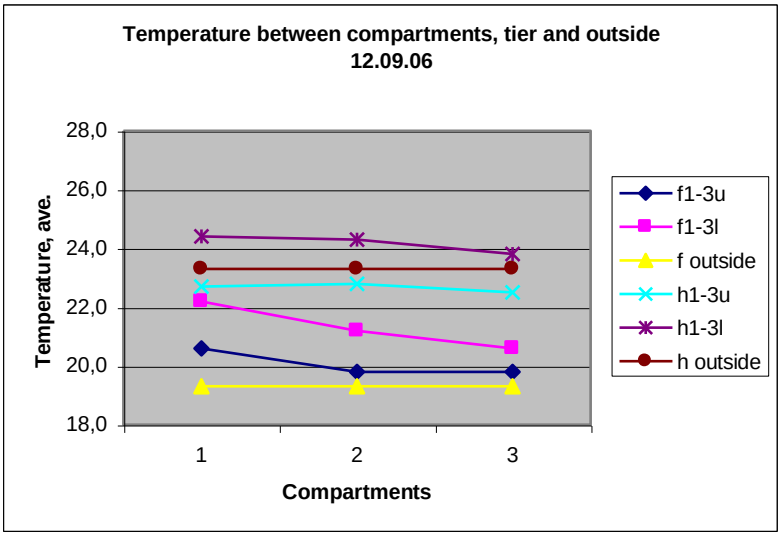
Slaughter pigs – Temperatures, correlation between fore carrier, tier, compartments and outdoor, winter



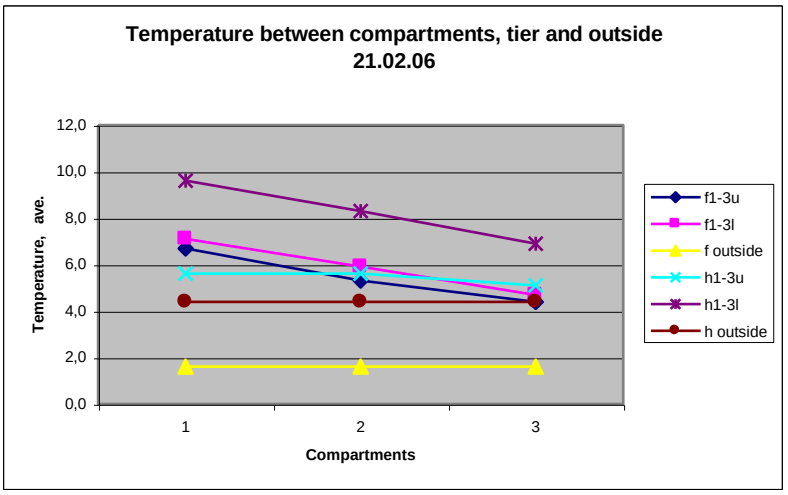


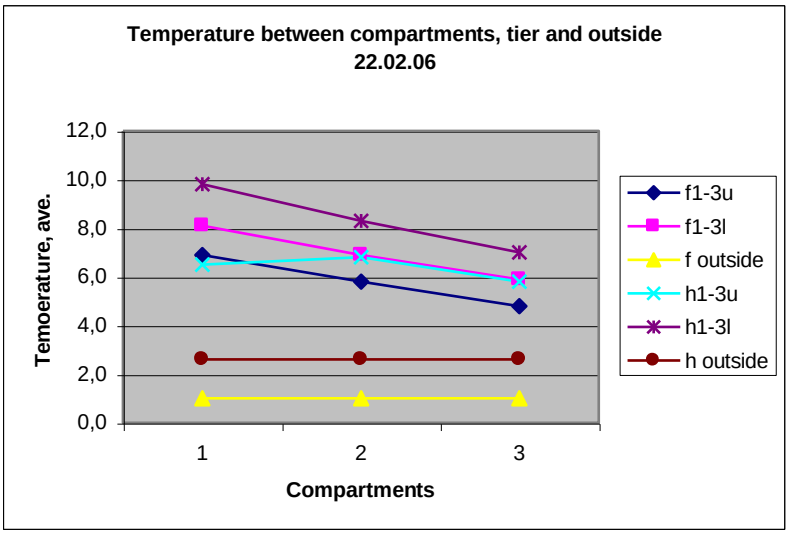
Sows – Temperatures, correlation between fore carrier, tier, compartments and outdoor, summer





Sows – Temperatures, correlation between fore carrier, tier, compartments and outdoor, winter





Attachment 6

Table A: Results of the investigations of the pigs on arrival at the abattoirs

Number Season	Date 2006	Animal type	No. of animals	Dead on arrival	DOA on ramp	Injuries general	Skin lesions	lameness	downers	Ear vein filling	Cannibalism
1 W	21./22.02.	sows	85	0	0	8	0	0	0	0	0
2 W	22./23.02.	sows	80	0	1	8	0	1	0	0	2
3 W	24./25.02.	fatteners	109	0	0	0	0	1	0	0	0
4 W	14.03.	piglets	480	0	0	0	0	0	0	0	ca. 48
5 W	17.03.	piglets	500	0	0	0	0	0	0	0	ca. 50
6 S	06.09.	fatteners	110	0	0	0	0	0	0	0	0
7 S	07.09.	fatteners	??????	0	0	1eye lost	Many	0	0	0	0
8 S	12.09.	sows	84	4	1	2 claws	0	6	2	0	0
9 S	13.09.	sows	84	0	0	0	0	0	0	0	0
10 S	13.09.	piglets	501	0	0	0	0	0	0	0	0
11 S	15.09.	piglets	500	0	0	bites ears	Many	0	0	0	0

Table B: Results of some investigations and handling of the pigs on arrival at the abattoirs

Current number	Ramp angle	Litter	Driving aids	Comments
1	even	wood chips	stick	
2	slight slope	wood chips	stick, paddle	Pig died of heart failure
3	slight slope	wood chips	stick, paddle	
4		wood chips	stick, shields	
5		wood chips	stick, shields, paddle	
6	approx. 25°	wood chips	stick, paddle	
7	approx. 25°	wood chips	stick, paddle	Many bites, density in waiting pen too high, general maltreatment
8	even	wood chips	stick, paddle	Haematomas, claws, rank fighting, DOA's in rear pens
9	even	wood chips	stick, paddle	
10		wood chips	paddle	1 piglet escaped, maltreated
11		wood chips	stick, paddle	Rank fighting, unrest

Attachment 7

The 11th September 2006, combination of negative temperatures and relative humidity

Time / room	F1U	F1UL	F1UR	RH	F2UL	F2UR	RH	F3UL	F3UR	RH	RH t out	t out
Vehicle laden 14:49 and driving 15:52 11-09-06												
14:45	27,6	29,2	29,2	64	28,1	27,0	62	29,1	28,4	58		
14:50	27,2	29,2	29,2	63	28,0	27,0	65	28,9	28,2	59		
14:55	28,3	29,2	29,4	64	28,0	27,4	66	28,9	28,2	61	25,0	58
15:00	27,2	28,4	29,1	61	27,2		61	27,9		59	25,2	61
15:05		27,7	28,5	60							25,3	60
15:10			28,0	59							25,2	60
15:15			27,5	61							25,0	61
max	**28,3**	**29,2**	**29,4**	**64**	**28,0**	**27,4**	**66**	**28,9**	**28,2**	**61**	**25,3**	**61**

Time / room	H1U	H1UL	H1UR	RH	H2U	H2UL	H2UR	RH	H3U	H3UL	H3UR	RH	H1LR	RH	H2L	H2LL	RH	H3LL	H3LR	RH	t out
Vehicle laden 14:49 and driving 15.52 11-09-06																					
14:45	26,5	28,2	27,9	70		28,1	28,9	66		30,0	29,2	57	27,6	59			58	28,4	27,4	59	28,1
14:50	27,2	28,1	27,9	67		27,9	28,5	69	27,6	29,8	29,0	57	27,6	59	27,4	27,4	59	28,6	27,4	58	28,0
14:55	27,2	28,1	27,9	70		27,9	28,0	71	27,9	29,8	29,1	63	27,8	66	27,5	27,6	69	28,8	27,7	61	27,9
15:00	26,9	27,5	27,3	67		27,4	27,4	70	26,9	28,8	27,7	63	27,7	65	27,5	27,5	73	28,3		62	27,7
15:05							27,2	67		27,6		58	27,5	59	27,5	27,2	63	27,8		60	27,5
15:10							27,1	63							27,5		61				27,5
15:15							27,0	65							27,4		60				27,5
15:20							26,9	67							27,2		63				27,5
15:25							27,2	69													27,6
15:40															27,0		67				28,1
15:45															27,0		66				28,1
15:55															27,0		66				27,9
max	**27,2**	**28,2**	**27,9**	**70**	**0,0**	**28,1**	**28,9**	**71**	**27,9**	**30,0**	**29,2**	**63**	**27,8**	**66**	**72,9**	**27,6**	**73**	**28,8**	**27,7**	**62**	**28,1**

The 12th September 2006, combination of negative temperatures and relative humidity

Time / room	H1L	RH	t out
Vehicle laden 16:52 and driving 17:34 Vehicle stop 02:51 (at abbatoir)			
13-09-06 00:16	26,0	90	19,3
13-09-06 00:21	26,0	90	19,7
13-09-06 00:26	26,4	90	19,8
13-09-06 00:31	27,6	92	20,0
max	**27,6**	**92**	**20,0**

Attachment 8

Piglets – Temperature, relative humidity and CO2 level for fore carriage, and hanger per tier, compartment and outdoor, summer

13.09.06	temperature								RH								CO2					
	F				H				F				H				F			H		
Upper	f1u	f2u	f3u	t out	h1u	h2u	h3u	t out	f1u	f2u	f3u	rh out	h1u	h2u	h3u		f1u	f2u	f3u	h1u	h2u	h3u
ave	**22,9**	**22,4**	**22,0**	**20,8**	**22,4**	**22,5**	**22,6**	**error**	**73**	**66**	**73**	**81**	**74**	**73**	**74**		**1232**	**1387**		**1361**	**1241**	
min	20,6	20,1	19,9	18,3	18,8	18,7	19,4	error	48	0	47	0	19	11	52		1020	1005		1050	1080	
max	26,7	26,3	26,2	27,6	26,5	26,3	27,1	error	97	99	99	99	99	99	99		1335	1920		2265	1950	
Mid	f1m	f2m	f3m		h1m	h2m	h3m		f1m	f2m	f3m		h1m	h2m	h3m		f1m	f2m	f3m	h1m	h2m	h3m
ave	**27,3**	**25,7**	**24,8**		**28,2**	**error**	**error**		**59**	**60**	**64**		**62**	**error**	**error**							
min	23,7	22,7	21,8		23,4	error	error		45	44	46		48	error	error							
max	32,2	31,0	30,2		31,8	error	error		75	78	86		96	error	error							
Lower	f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l	h1l	h2l	h3l
ave	**28,9**	**26,3**	**23,6**		**27,6**	**27,1**	**26,6**		**64**	**61**	**63**		**fejl**		**60**	**61**	**1454**		**1390**	**1287**		**1210**
min	25,6	24,3	21,1		24,5	24,1	23,6		46	48	47		fejl		45	46	1200		1185	1125		1065
max	31,7	30,3	28,4		30,4	30,3	30,2		86	79	78		fejl		75	81	2610		2205	1785		2055

15.09.06	temperature								RH								CO2					
	F				H				F				H				F			H		
Upper	f1u	f2u	f3u	t out	h1u	h2u	h3u	t out	f1u	f2u	f3u	rh out	h1u	h2u	h3u		f1u	f2u	f3u	h1u	h2u	h3u
ave	**25,4**	**24,8**	**24,8**	**23,3**	**24,5**	**24,3**	**24,4**	**26,3**	**59**	**60**	**59**	**58**	**58**	**60**	**58**		**1163**	**1309**		**1307**	**1307**	
min	20,9	20,6	20,9	19,7	18,5	18,6	18,8	22,8	41	41	40	37	41	42	41		1065	1050		1065	1065	
max	27,9	27,1	27,1	26,1	27,6	27,5	27,4	28,9	86	89	86	91	78	78	78		1275	2070		2430	2430	
Mid	f1m	f2m	f3m		h1m	h2m	h3m		f1m	f2m	f3m		h1m	h2m	h3m		f1m	f2m	f3m	h1m	h2m	h3m
ave	**29,3**	**27,4**	**26,6**		**28,1**	**error**	**26,6**		**52**	**52**	**55**		**53**	**error**	**56**							
min	26,5	24,4	22,4		25,1	error	22,7		37	37	40		37	error	39							
max	31,8	31,0	32,6		30,2	error	30,2		71	64	71		67	error	72							
Lower	f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l	h1l	h2l	h3l
ave	**29,0**	**27,5**	**24,9**		**27,0**	**26,3**	**25,6**		**51**	**53**	**53**		**16**		**55**	**55**	**1378**		**1322**	**1273**		**1206**
min	26,0	24,3	21,2		20,5	20,7	20,1		38	39	41		0		37	37	1125		1125	1065		1035
max	31,5	30,9	30,4		29,8	30,5	29,9		62	67	67		97		76	71	2325		1965	1710		2175

Piglets – Temperature, relative humidity and CO2 level for fore carriage, and hanger per tier, compartment and outdoor, winter

14.03.06	temperature								RH								CO2					
	F				H				F				H				F			H		
Upper	f1u	f2u	f3u	t out	h1u	h2u	h3u	t out	f1u	f2u	f3u	rh out	h1u	h2u	h3u		f1u	f2u	f3u	h1u	h2u	h3u
ave	**10,1**	**9,0**	**7,5**	**error**	**8,5**	**9,1**	**8,4**	**3,3**	**70**	**65**	**68**	**error**	**57**	**58**	**59**		**727**	**671**		**678**	**674**	
min	6,6	4,9	3,6	error	4,4	5,4	5,3	1,1	51	44	50	error	0	0	0		585	495		525	495	
max	18,6	19,5	17,7	error	13,3	14,1	14,2	7,0	99	99	99	error	98	99	99		825	780		765	765	
Mid	f1m	f2m	f3m		h1m	h2m	h3m		f1m	f2m	f3m		h1m	h2m	h3m		f1m	f2m	f3m	h1m	h2m	h3m
ave	**21,3**	**15,7**	**12,5**		**18,5**	**18,8**	**16,8**		**47**	**51**	**55**		**51**	**47**	**50**							
min	16,8	10,4	6,7		7,2	5,7	6,9		24	34	34		21	15	12							
max	28,7	27,2	27,2		25,1	23,7	23,7		71	81	88		94	77	97							
Lower	f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l	h1l	h2l	h3l
ave	**22,1**	**18,1**	**13,2**		**15,5**	**14,1**	**14,5**		**39**	**38**	**49**		**error**	**error**	**error**		**676**		**671**	**error**		**error**
min	18,3	14,6	7,7		0,4	-0,4	1,6		28	29	29		error	error	error		525		465	error		error
max	24,9	25,0	24,1		19,8	19,0	18,9		61	56	73		error	error	error		765		765	error		error

17.03.06	temperature								RH							CO2				
	F				H				F				H			F			H	
Upper	f1u	f2u	f3u	t out	h1u	h2u	h3u	t out	f1u	f2u	f3u	rh out	h1u	h2u	h3u	f1u	f2u	f3u	h1u	h2u h3u
ave	**10,7**	**9,2**	**8,0**	**2,1**	**9,7**	**9,8**	**9,1**	**4,8**	**74**	**73**	**75**	**82**	**62**	**56**	**60**	**777**	**1050**		**1003**	**863**
min	3,0	2,9	4,4	-1,0	2,3	1,9	3,9	1,1	0	55	59	63	0	0	0	600	540		555	540
max	18,4	17,8	14,5	5,9	17,2	17,9	15,4	7,6	99	99	99	94	99	99	99	900	1920		1845	1305
Mid	f1m	f2m	f3m		h1m	h2m	h3m		f1m	f2m	f3m		h1m	h2m	h3m	f1m	f2m	f3m	h1m	h2m h3m
ave	**24,7**	**19,6**	**14,0**		**19,9**	**error**	**17,2**		**49**	**53**	**61**		**56**	**error**	**57**					
min	10,9	8,5	7,7		3,1	error	3,4		32	40	42		5	error	24					
max	29,1	25,4	22,7		26,9	error	24,7		86	88	94		97	error	99					
Lower	f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l		h1l	h2l	h3l	f1l	f2l	f3l	h1l	h2l h3l
ave	**20,1**	**16,6**	**13,6**		**18,7**	**16,7**	**15,4**		**46**	**52**	**55**		**50**	**49**	**56**	**804**	**772**		**1410**	**1232**
min	11,3	8,9	8,8		0,4	-0,2	-0,2		33	42	44		2	0	0	585	585		555	525
max	24,7	22,2	18,7		23,4	22,6	22,7		74	78	73		98	90	99	1035	930		2070	1875

Slaughter pigs – Temperature, relative humidity and CO2 level for fore carriage, and hanger per tier, compartment and outdoor, summer.

06.09.06	temperature								RH							CO2				
	F				H				F				H			F			H	
Upper	f1u	f2u	f3u	t out	h1u	h2u	h3u	t out	f1u	f2u	f3u	rh out	h1u	h2u	h3u	f1u	f2u	f3u	h1u	h2u h3u
ave	**23,4**	**22,8**	**22,9**	**22,2**	**23,5**	**23,5**	**23,4**	**23,2**	**76**	**80**	**77**	**80**	**72**	**73**	**77**	**947**	**1073**		**1069**	**1005**
min	20,1	19,8	19,8	19,8	19,8	20,0	19,2	19,3	63	67	64	0	13	0	4	780	780		795	765
max	26,2	25,6	25,0	24,6	26,0	25,9	25,6	25,5	96	99	94	99	97	99	99	1170	2835		2805	1695
Mid	f1m	f2m	f3m		h1m	h2m	h3m		f1m	f2m	f3m		h1m	h2m	h3m	f1m	f2m	f3m	h1m	h2m h3m
ave					25,2	25,9	24,7						**75**	**71**	**73**					
min					20,8	20,8	21,1						59	2	57					
max					31,0	30,6	31,4						94	99	93					
Lower	f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l		h1l	h2l	h3l	f1l	f2l	f3l	h1l	h2l h3l
ave	**24,6**	**24,0**	**23,6**		**25,6**	**25,7**	**25,5**		**72**	**74**	**74**		**69**	**71**	**70**	**1008**	**987**		**1104**	**973**
min	20,9	20,6	20,4		21,2	21,4	21,3		60	63	62		2	57	56	750	735		780	705
max	27,2	26,9	26,9		29,8	30,3	30,3		81	82	83		98	90	87	2070	1800		1845	1515

07.09.06	temperature								RH							CO2				
	F				H				F				H			F			H	
Upper	f1u	f2u	f3u	t out	h1u	h2u	h3u	t out	f1u	f2u	f3u	rh out	h1u	h2u	h3u	f1u	f2u	f3u	h1u	h2u h3u
ave	**18,6**	**18,0**	**18,3**	**17,5**	**18,9**	**18,6**	**18,7**	**20,5**	**68**	**71**	**68**	**73**	**66**	**70**	**71**	**1031**	**1129**		**1118**	**1051**
min	15,2	14,9	15,1	14,4	14,9	14,8	15,0	17,8	58	60	59	51	0	59	61	825	870		900	885
max	20,8	20.1	20,2	22,8	21,0	20,6	20,7	22,7	89	88	85	99	99	99	99	1125	2190		1770	1785
Mid	f1m	f2m	f3m		h1m	h2m	h3m		f1m	f2m	f3m		h1m	h2m	h3m	f1m	f2m	f3m	h1m	h2m h3m
ave					**22,1**	**22,4**	**20,7**						**62**	**60**	**62**					
min					18,0	17,7	18,0						51	50	46					
max					25,8	26,5	26,5						94	99	92					
Lower	f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l		h1l	h2l	h3l	f1l	f2l	f3l	h1l	h2l h3l
ave	**19,9**	**19,3**	**19,0**		**21,9**	**20,7**	**21,5**		**63**	**66**	**66**		**error**	**62**	**59**	**1112**	**1106**		**error**	**1020**
min	17,8	17,4	17,1		17,9	18,1	18,2		55	57	57		error	51	52	850	840		error	855
max	21,5	21,4	21,9		25,1	24,4	25,4		83	86	86		error	92	90	1830	1545		error	1350

Slaughter pigs – Temperature, relative humidity and CO2 level for fore carriage, and hanger per tier, compartment and outdoor, winter.

20.02.06	temperature									RH								CO2					
	F				H					F				H				F			H		
Upper	f1u	f2u	f3u	t out	h1u	h2u	h3u	t out		f1u	f2u	f3u	rh out	h1u	h2u	h3u		f1u	f2u	f3u	h1u	h2u	h3u
ave	**7,7**	**6,7**	**6,5**	**error**	**9,3**	**9,5**	**8,8**	**5,9**		**error**	**83**	**85**	**error**	**77**	**72**	**64**		**error**	**955**		**937**		**781**
min	3,4	4,1	3,7	error	6,3	6,3	5,7	4,3		error	59	65	error	6	0	0		error	480		585		480
max	12,8	12,8	11,9	error	16,9	17,8	16,2	7,2		error	99	99	error	99	99	99		error	2100		1695		1665
Mid	f1m	f2m	f3m		h1m	h2m	h3m			f1m	f2m	f3m		h1m	h2m	h3m		f1m	f2m	f3m	h1m	h2m	h3m
ave					**19,3**	**17,2**	**16,1**							**51**	**56**	**56**							
min					16,0	10,9	9,6							12	21	21							
max					24,7	26,1	26,9							97	96	96							
Lower	f1l	f2l	f3l		h1l	h2l	h3l			f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l	h1l	h2l	h3l
ave	**13,1**	**11,0**	**9,5**		**17,9**	**16,4**	**17,1**			**61**	**68**	**73**		**49**	**51**	**47**		**1020**	**1039**		**1142**		**931**
min	7,4	7,0	6,5		14,4	12,0	12,2			48	50	55		34	30	7		675	555		510		480
max	17,7	16,2	15,4		22,7	22,1	24,9			84	96	95		99	99	99		1890	2070		1830		1785

23.02.06	temperature									RH								CO2					
	F				H					F				H				F			H		
Upper	f1u	f2u	f3u	t out	h1u	h2u	h3u	t out		f1u	f2u	f3u	rh out	h1u	h2u	h3u		f1u	f2u	f3u	h1u	h2u	h3u
ave	**5,5**	**4,6**	**4,4**	**1,5**	**7,8**	**8,3**	**7,7**	**error**		**87**	**88**	**87**	**81**	**64**	**62**	**65**		**824**	**1032**		**976**		**901**
min	2,9	2,0	1,7	-0,1	3,7	4,4	3,7	error		73	73	74	0	0	0	0		705	690		705		720
max	11,3	10,6	11,6	6,0	13,6	13,5	14,2	error		99	99	99	99	99	99	99		930	1620		1425		1605
Mid	f1m	f2m	f3m		h1m	h2m	h3m			f1m	f2m	f3m		h1m	h2m	h3m		f1m	f2m	f3m	h1m	h2m	h3m
ave					**17,6**	**17,6**	**14,2**							**60**	**55**	**62**							
min					9,3	8,8	9,6							14	18	5							
max					21,8	22,1	18,0							91	85	99							
Lower	f1l	f2l	f3l		h1l	h2l	h3l			f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l	h1l	h2l	h3l
ave	**13,3**	**10,4**	**8,1**		**16,2**	**14,6**	**13,5**			**66**	**74**	**73**		**48**	**51**	**55**		**865**	**1032**		**1252**		**1134**
min	10,8	7,6	5,1		8,0	6,8	6,7			50	55	1		0	0	0		705	795		765		915
max	17,0	18,3	18,2		19,6	18,5	17,0			99	99	99		85	99	99		1410	1365		1980		1755

Sows – Temperature, relative humidity and CO2 level for fore carriage, and hanger per tier, compartment and outdoor, summer.

11.09.06	temperature									RH								CO2					
	F				H					F				H				F			H		
Upper	f1u	f2u	f3u	t out	h1u	h2u	h3u	t out		f1u	f2u	f3u	rh out	h1u	h2u	h3u		f1u	f2u	f3u	h1u	h2u	h3u
ave	**23,2**	**22,2**	**21,8**	**21,3**	**22,7**	**22,8**	**22,5**	**23,3**		**70**	**71**	**69**	**70**	**72**	**72**	**70**		**1096**	**949**		**932**		**1193**
min	18,9	18,4	17,6	15,7	17,9	18,5	18,5	18,5		51	50	49	46	54	54	51		945	885		885		945
max	29,0	27,3	28,1	30,3	27,8	27,8	29,0	28,7		93	99	92	99	99	99	99		1215	990		1005		1950
Lower	f1l	f2l	f3l		h1l	h2l	h3l			f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l	h1l	h2l	h3l
ave	**24,3**	**23,3**	**22,6**		**24,4**	**24,3**	**23,8**			**64**	**65**	**66**		**64**	**66**	**65**		**1129**	**1037**		**948**		**1061**
min	21,1	19,5	18,5		21,2	20,8	20,2			50	52	49		51	53	50		975	885		885		930
max	28,0	27,6	27,6		27,4	27,3	27,9			78	80	84		89	89	90		1995	3090		1170		1890

12.09.06	temperature									RH								CO2					
	F				H					F				H				F			H		
Upper	f1u	f2u	f3u	t out	h1u	h2u	h3u	t out		f1u	f2u	f3u	rh out	h1u	h2u	h3u		f1u	f2u	f3u	h1u	h2u	h3u
ave	**20,6**	**19,8**	**19,8**	**19,3**	**21,3**	**20,9**	**20,5**	**21,4**		**76**	**78**	**75**	**79**	**74**	**75**	**75**		**1171**	**1601**		**error**		**1298**
min	17,3	16,4	16,3	13,9	18,0	17,0	17,5	18,1		61	61	59	60	61	62	59		1065	945		error		1020
max	25,6	23,9	24,3	24,7	25,0	24,8	24,5	26,2		89	97	88	99	97	99	96		1245	3150		error		2310
Lower	f1l	f2l	f3l		h1l	h2l	h3l			f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l	h1l	h2l	h3l
ave	**22,2**	**21,2**	**20,6**		**22,5**	**22,3**	**22,1**			**70**	**72**	**72**		**75**	**72**	**72**		**1448**	**1185**		**1290**		**1151**
min	19,2	17,6	17,1		19,3	19,4	19,8			59	59	58		59	61	60		1005	1020		1050		1005
max	26,2	25,2	24,7		26,0	25,5	25,7			95	95	84		96	99	99		3360	1740		3315		1485

Sows – Temperature, relative humidity and CO2 level for fore carriage, and hanger per tier, compartment and outdoor, winter.

21.02.06	temperature								RH							CO2					
	F				H				F				H			F			H		
Upper	f1u	f2u	f3u	t out	h1u	h2u	h3u	t out	f1u	f2u	f3u	rh out	h1u	h2u	h3u	f1u	f2u	f3u	h1u	h2u	h3u
ave	**6,7**	**5,3**	**4,4**	1,6	**5,6**	**5,6**	**5,1**	4,4	**75**	**77**	**79**	**83**	**76**	**77**	**78**	**776**		**775**	**836**		**783**
min	2,7	1,1	1,3	0,2	2,3	2,6	2,8	2,8	65	65	69	71	68	69	70	645		630	645		600
max	10,2	8,6	8,2	9,2	6,9	7,6	7,5	5,9	99	99	99	92	99	99	96	885		1380	1305		1335
Lower	f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l		h1l	h2l	h3l	f1l	f2l	f3l	h1l	h2l	h3l
ave	**7,1**	**5,9**	**4,7**		**9,6**	**8,3**	**6,9**		**70**	**75**	**77**		**68**	**72**	**74**	**873**		**990**	**995**		**815**
min	5,2	4,1	3,2		3,3	2,4	1,3		59	62	61		57	62	65	705		660	615		645
max	12,3	11,4	10,3		11,1	10,8	9,8		92	92	96		99	99	99	1365		1590	1800		1395

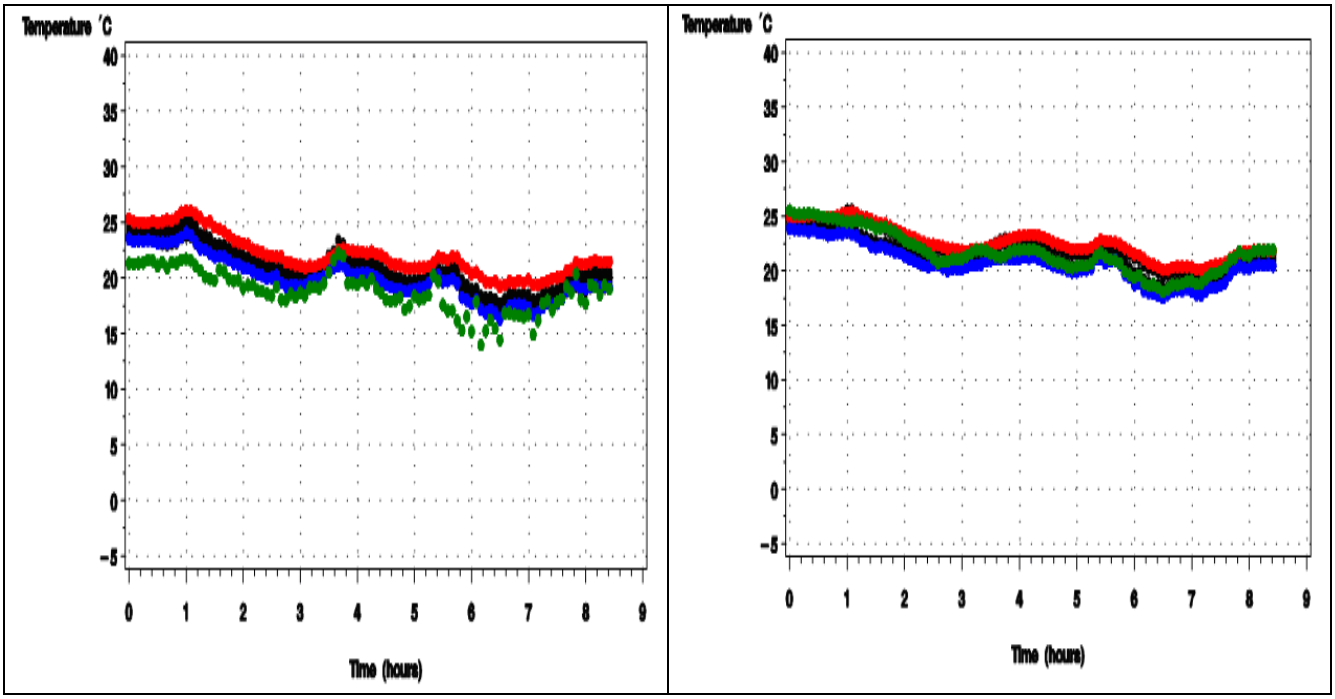
22.02.06	temperature								RH							CO2					
	F				H				F				H			F			H		
Upper	f1u	f2u	f3u	t out	h1u	h2u	h3u	t out	f1u	f2u	f3u	rh out	h1u	h2u	h3u	f1u	f2u	f3u	h1u	h2u	h3u
ave	**6,9**	**5,8**	**4,8**	1,0	**6,5**	**6,8**	**5,8**	2,6	**72**	**72**	**74**	**71**	**76**	**76**	**74**	**800**		**939**	**974**		**992**
min	4,1	2,8	2,1	-0,7	3,0	3,6	3,3	1,4	59	60	61	45	62	63	61	705		705	690		720
max	14,2	15,5	13,8	8,7	10,9	10,8	10,7	4,8	99	99	99	82	99	99	99	915		1965	2535		2505
Lower	f1l	f2l	f3l		h1l	h2l	h3l		f1l	f2l	f3l		h1l	h2l	h3l	f1l	f2l	f3l	h1l	h2l	h3l
ave	**8,1**	**6,9**	**5,9**		**9,8**	**8,3**	**7,0**		**60**	**65**	**65**		**66**	**68**	**82**	**1027**		**1151**	**1186**		**998**
min	6,5	4,9	3,1		1,3	1,2	1,1		51	55	55		50	55	66	780		855	675		750
max	11,1	12,0	14,0		12,7	11,5	9,7		84	90	97		99	99	99	2250		1755	2370		3060

Attachment 9

Sows

Temperature over time during summer transports

O	Logger in F1L/H1L	O	Logger in F3U/H3U	O	Rest of loggers	O	Outdoor logger

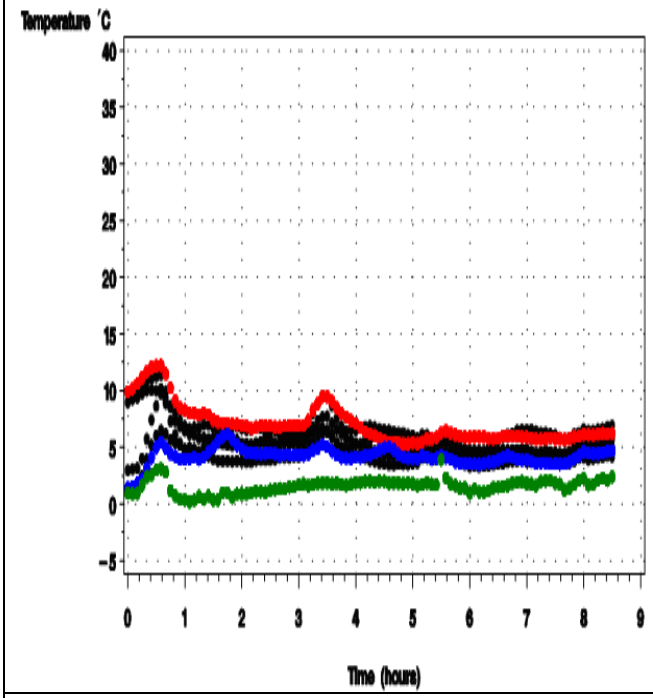


Sows

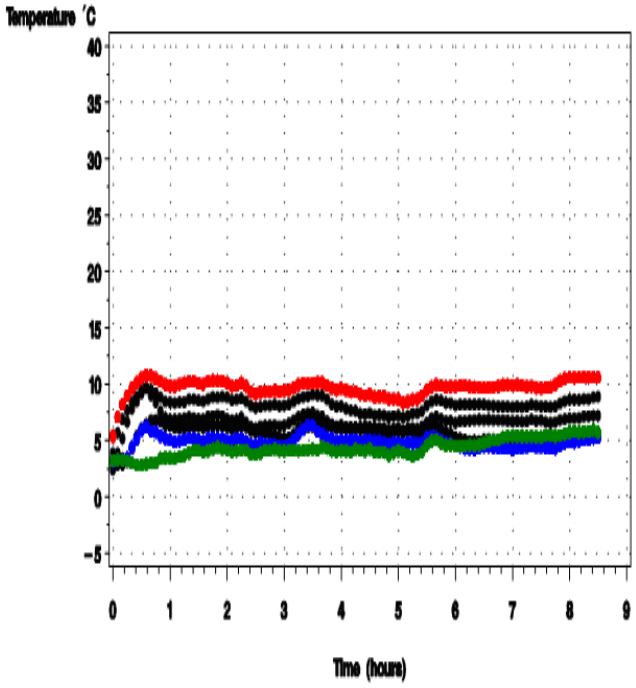
Temperature over time during winter transports

Logger in F1L/H1L **Logger in F3U/H3U** **Rest of loggers** **Outdoor logger**

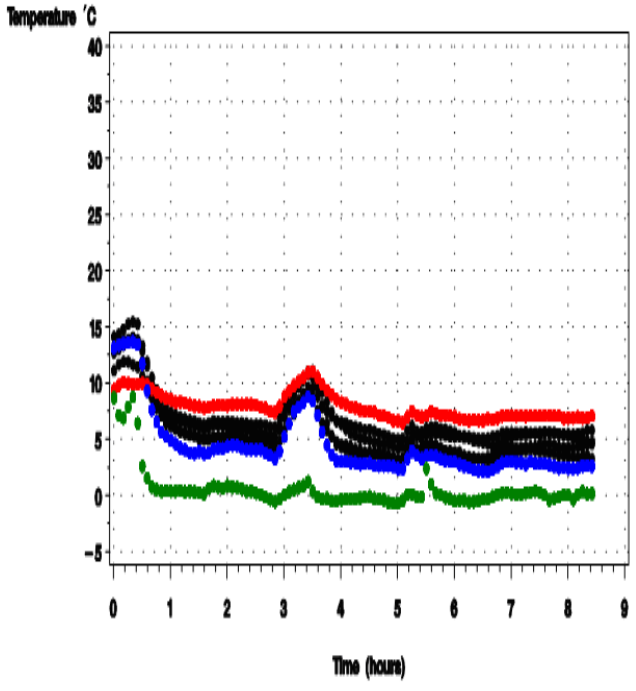
Fore-carriage – Repetition No 1



Hanger – Repetition No 1



Fore-carriage – Repetition No 2



Hanger – Repetition No 2

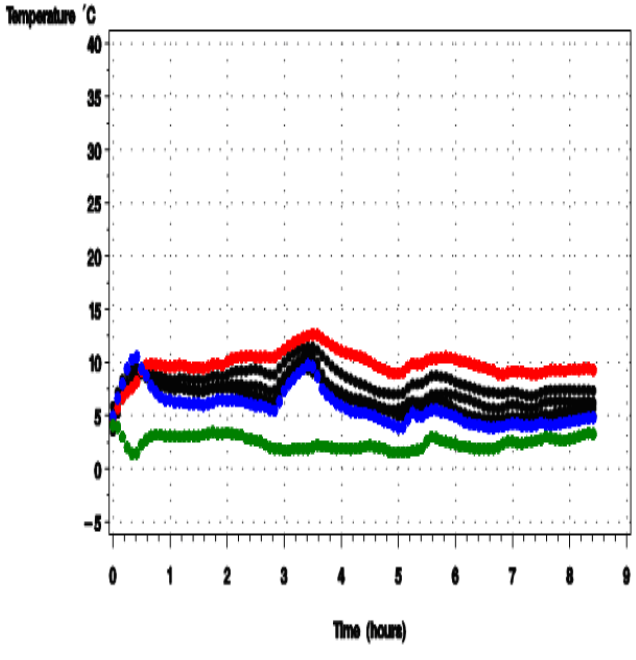
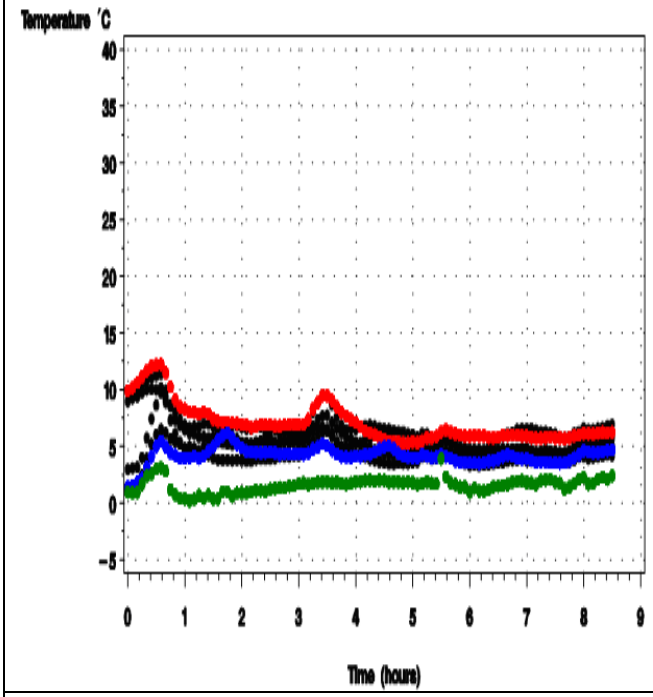
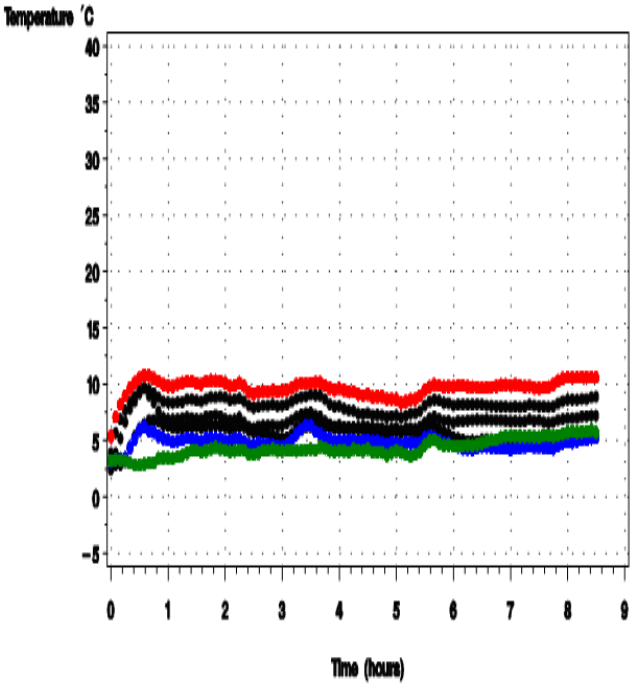
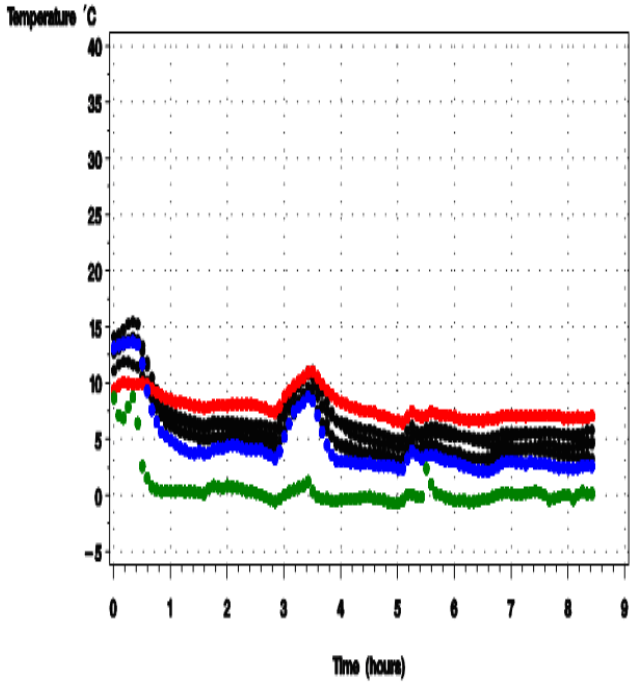
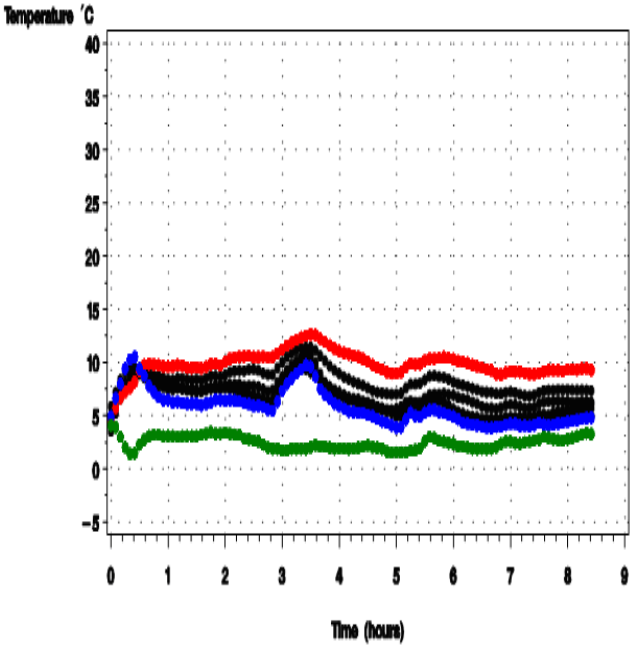


Exhibit No. 3

Fore-carriage – Repetition No 1	Hanger – Repetition No 1
	
Fore-carriage – Repetition No 2	**Hanger – Repetition No 2**
	

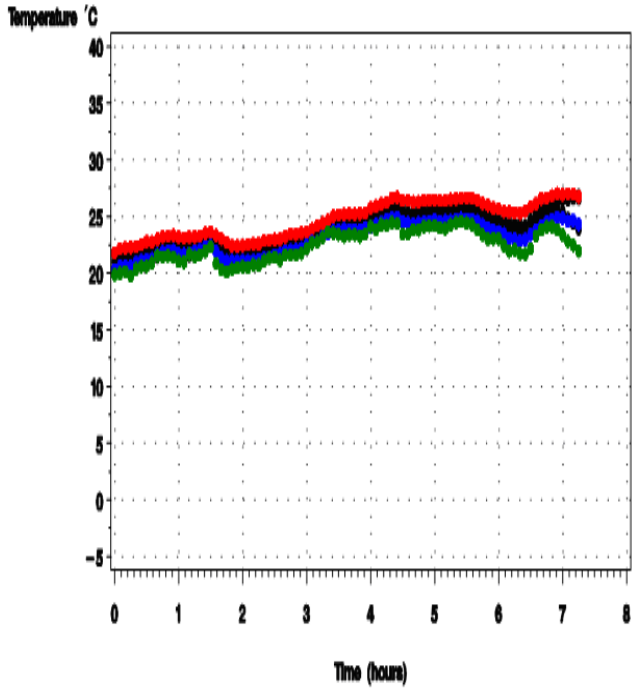
Attachment 10

Slaughter pigs

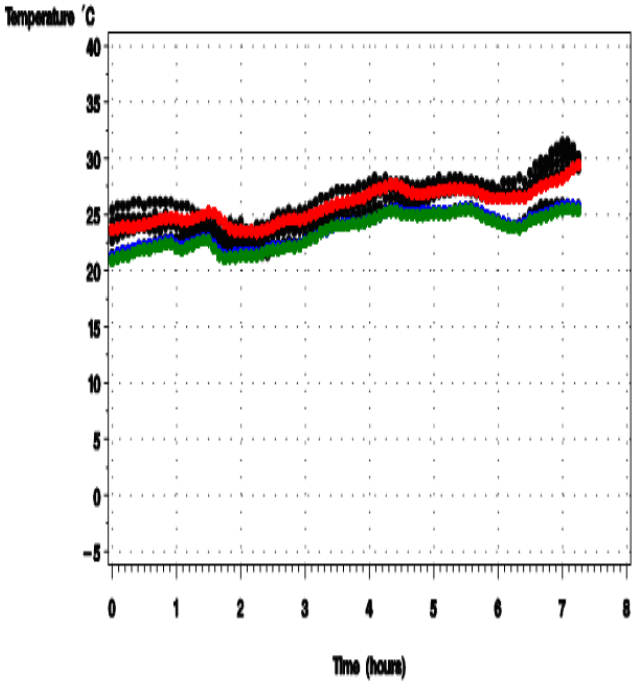
Temperature over time during summer transports

O **Logger in F1L/H1L** O **Logger in F3U/H3U** O **Rest of loggers** O **Outdoor logger**

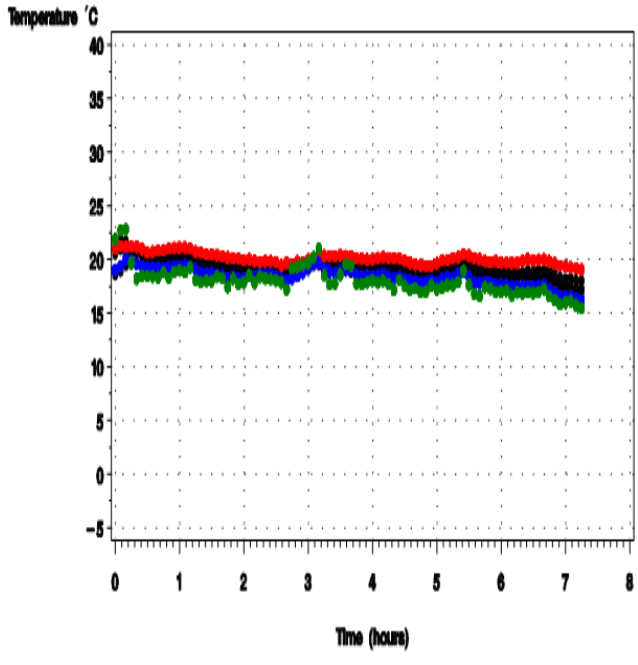
Fore-carriage – Repetition No 1



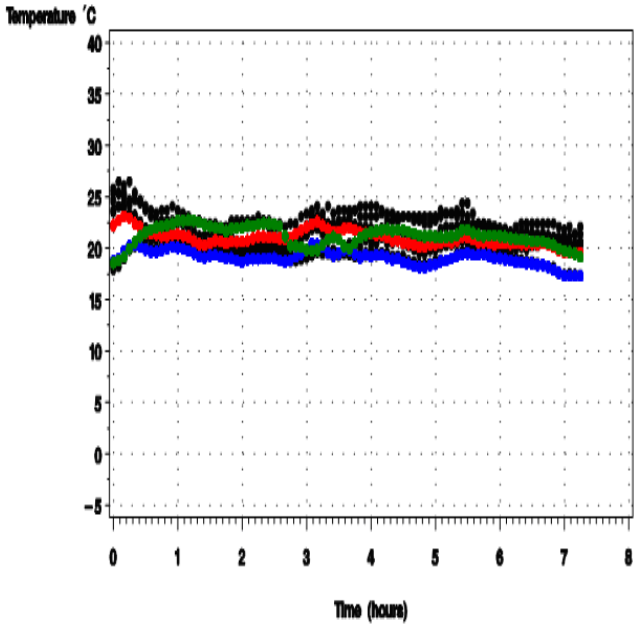
Hanger – Repetition No 1



Fore-carriage – Repetition No 2



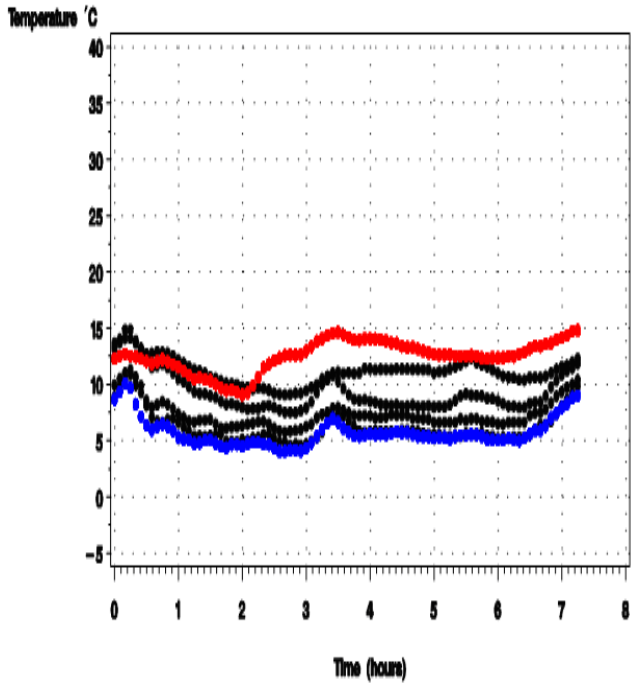
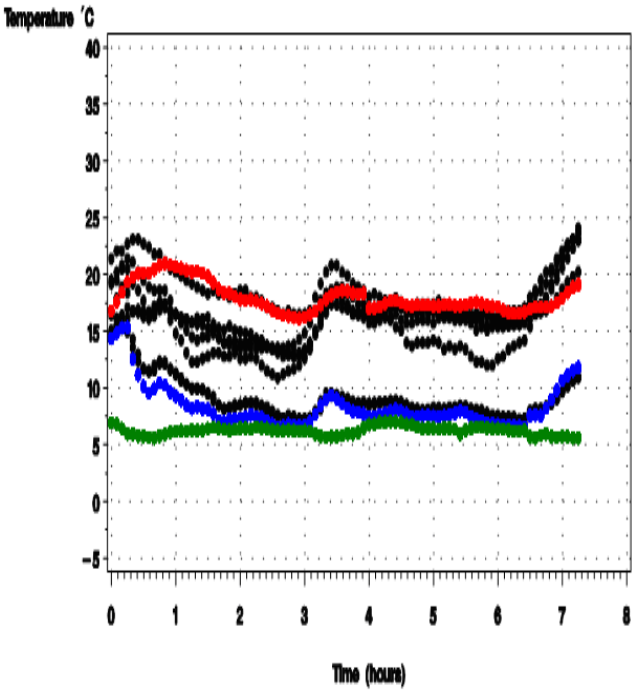
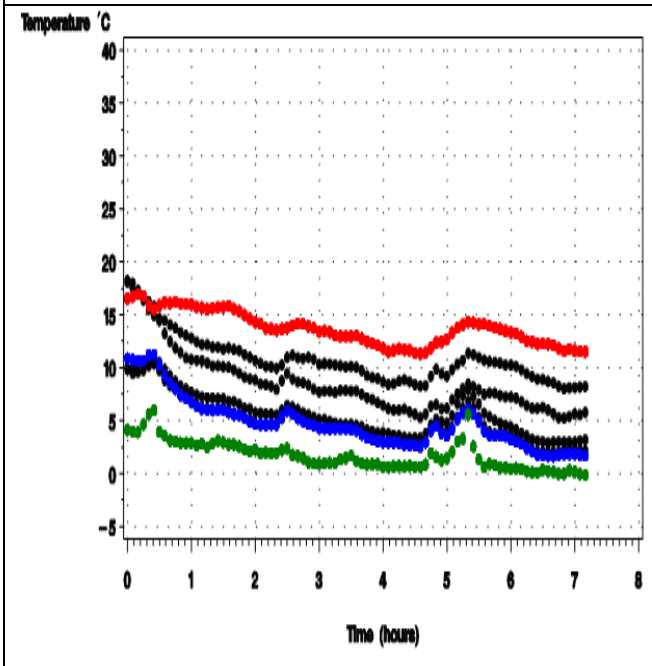
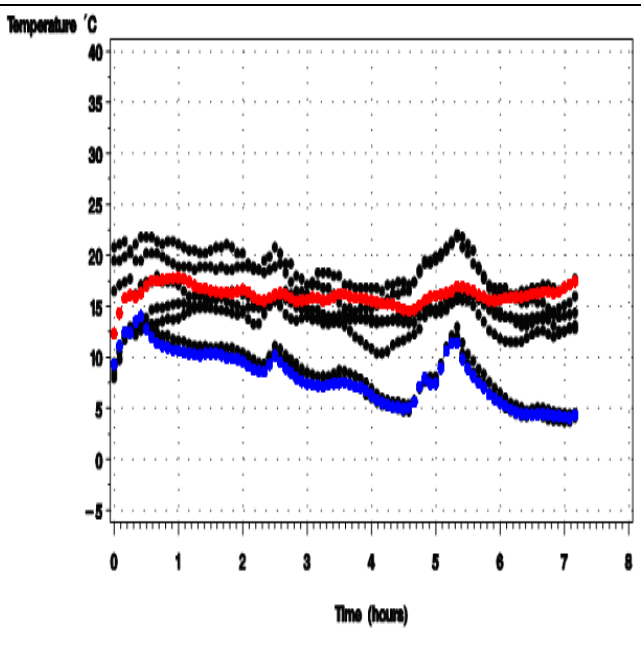
Hanger – Repetition No 2



Slaughter pigs

Temperature over time during winter transports

O **Logger in F1L/H1L** O **Logger in F3U/H3U** O **Rest of loggers** O **Outdoor logger**

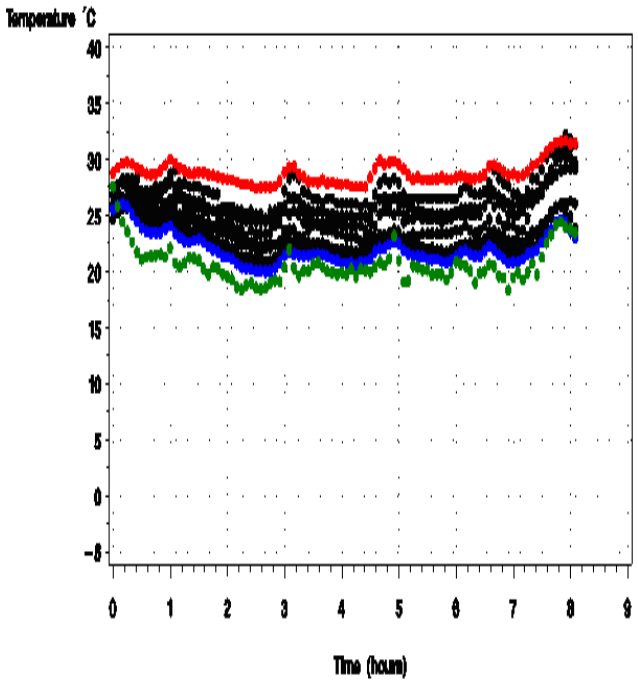
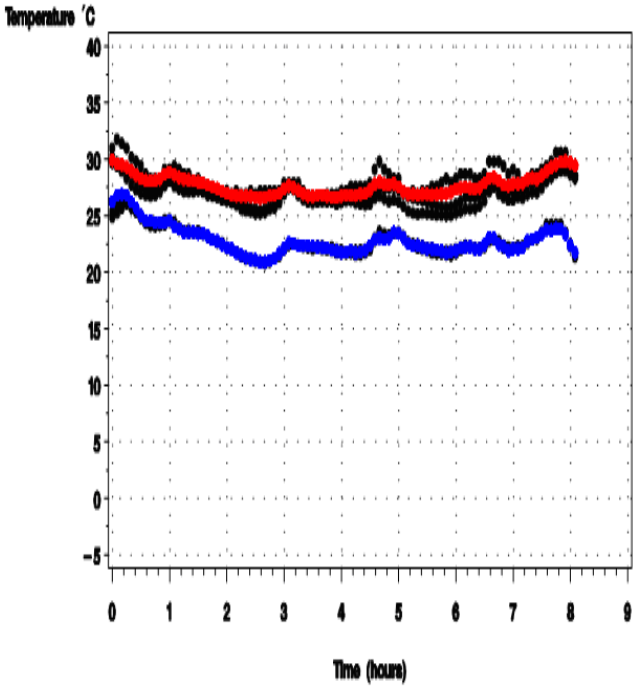
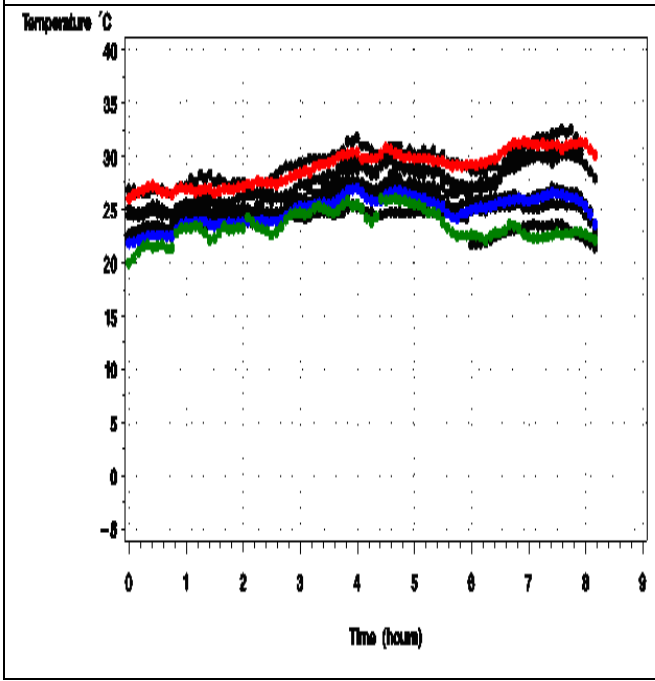
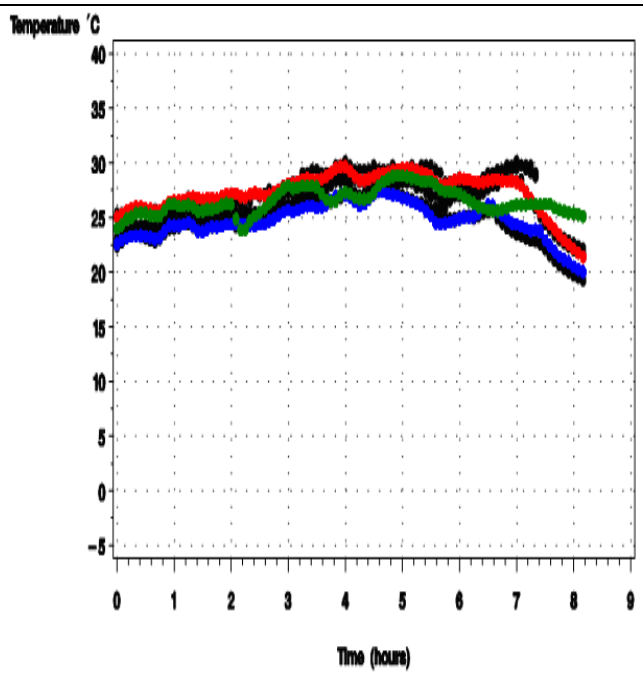
Fore-carriage – Repetition No 1	Hanger – Repetition No 1
	
Fore-carriage – Repetition No 2	**Hanger – Repetition No 2**
	

Attachment 11

Piglets

Temperature over time during summer transports

O **Logger in F1L/H1L** O **Logger in F3U/H3U** O **Rest of loggers** O **Outdoor logger**

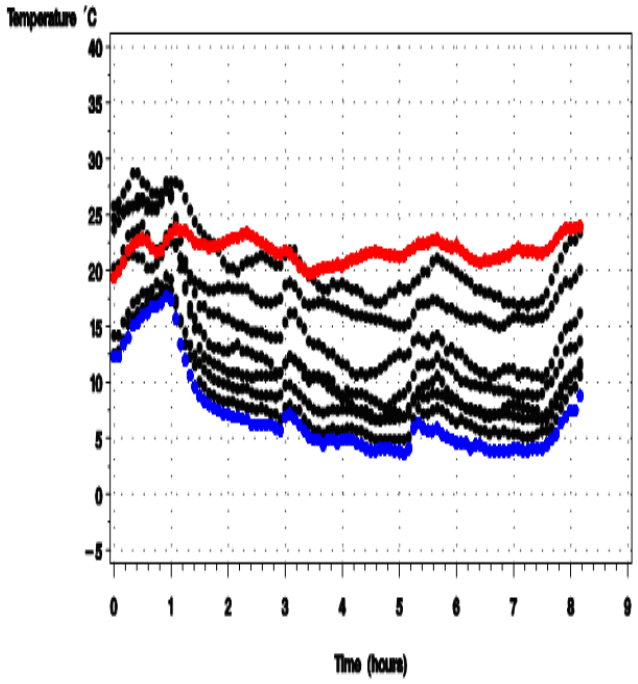
Fore-carriage – Repetition No 1	Hanger – Repetition No 1
	
Fore-carriage – Repetition No 2	**Hanger – Repetition No 2**
	

Piglets

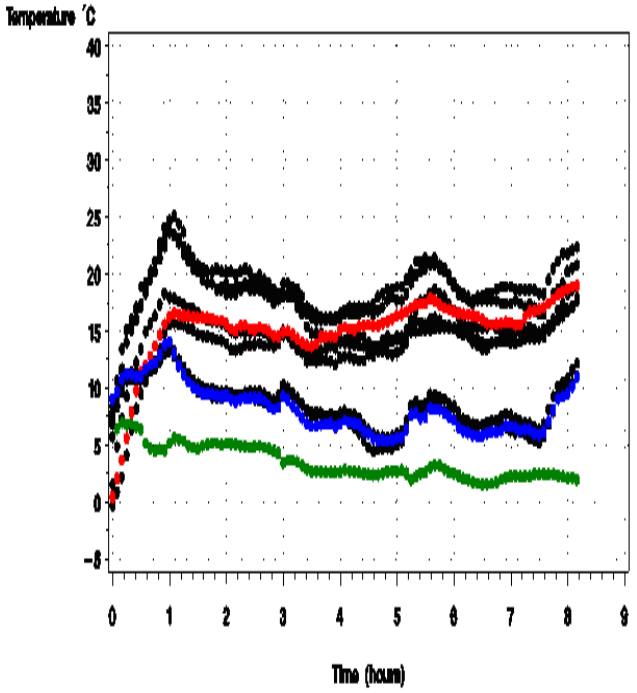
Temperature over time during winter transports

Logger in F1L/H1L **Logger in F3U/H3U** **Rest of loggers** **Outdoor logger**

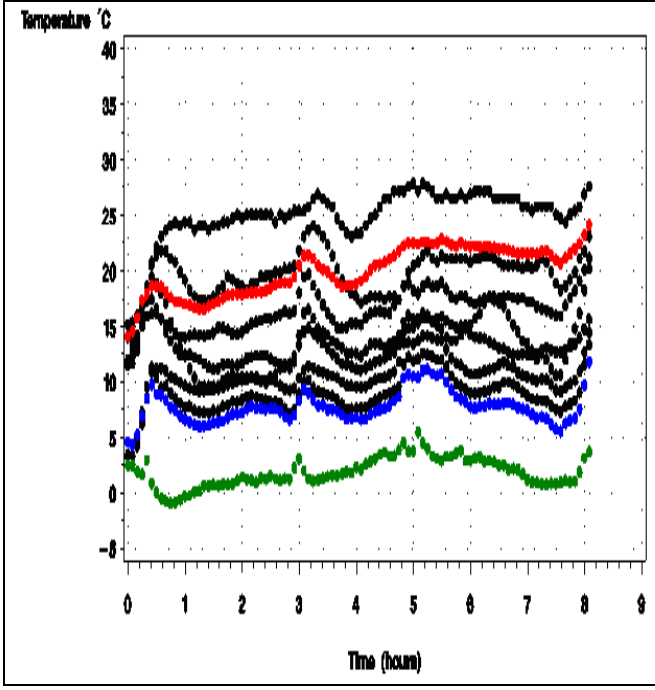
Fore-carriage – Repetition No 1



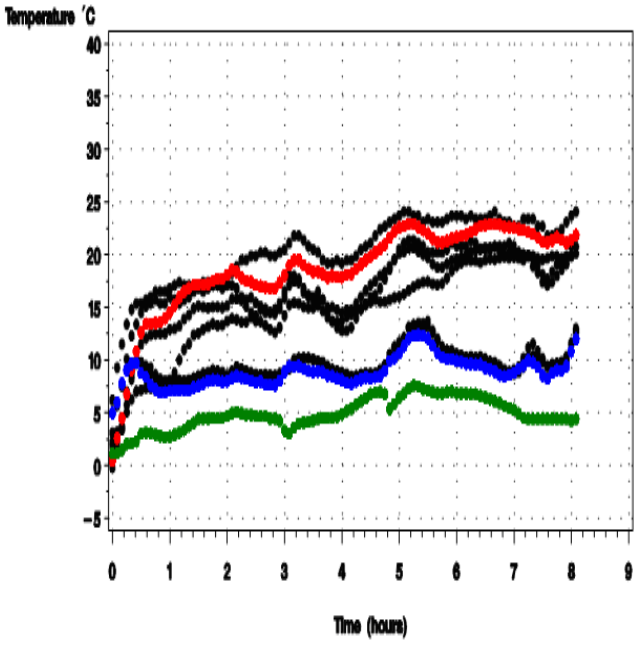
Hanger – Repetition No 1



Fore-carriage – Repetition No 2



Hanger – Repetition No 2

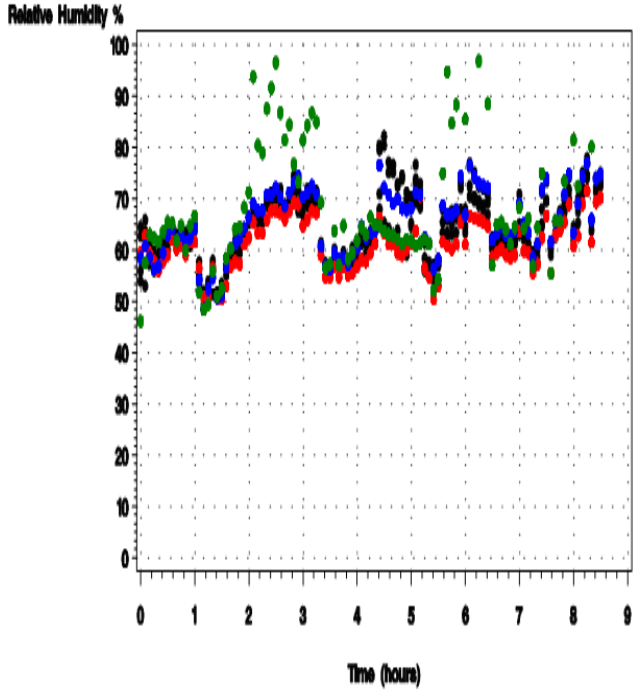
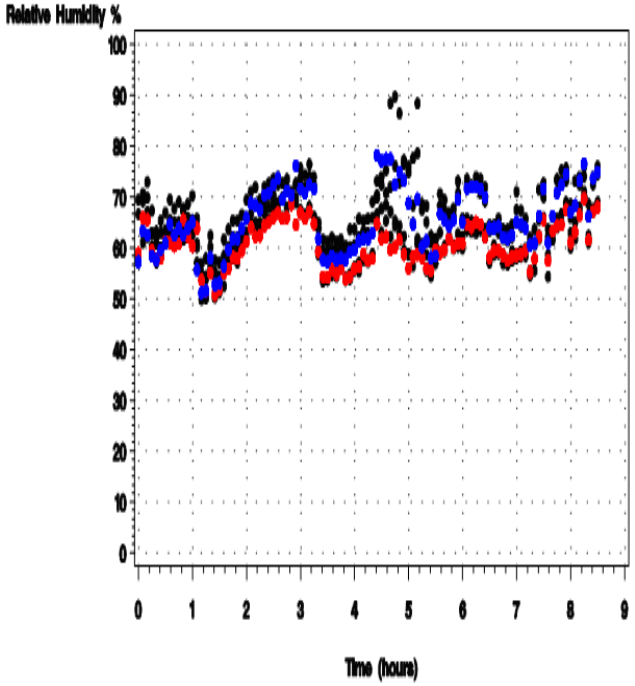
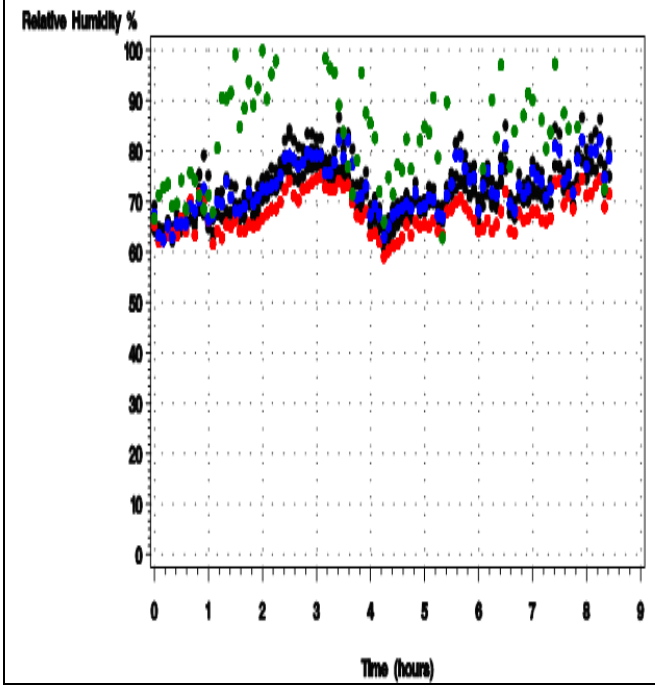
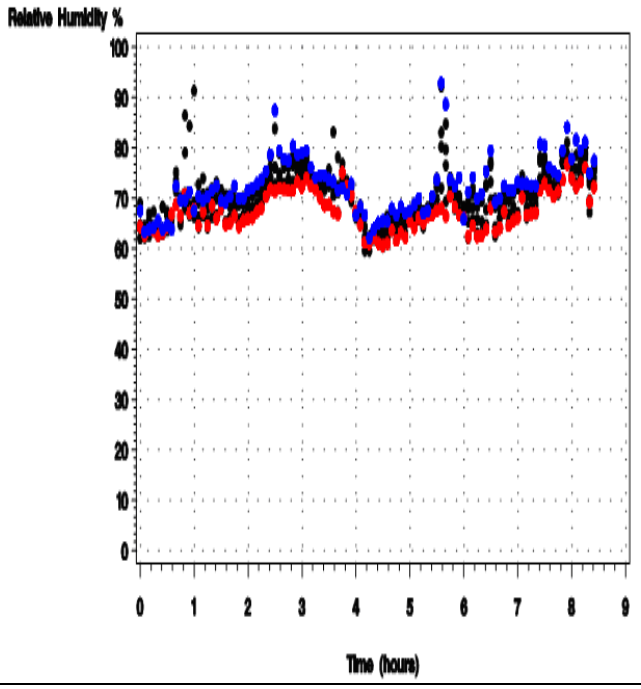


Attachment 12

Sows

Relative humidity over time during summer transports

O **Logger in F1L/H1L** O **Logger in F3U/H3U** O **Rest of loggers** O **Outdoor logger**

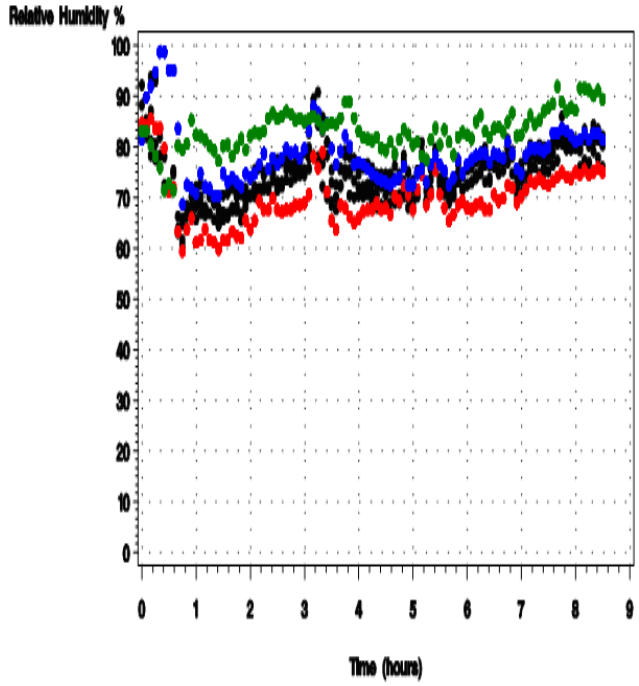
Fore-carriage – Repetition No 1	Hanger – Repetition No 1
	
Fore-carriage – Repetition No 2	**Hanger – Repetition No 2**
	

Sows

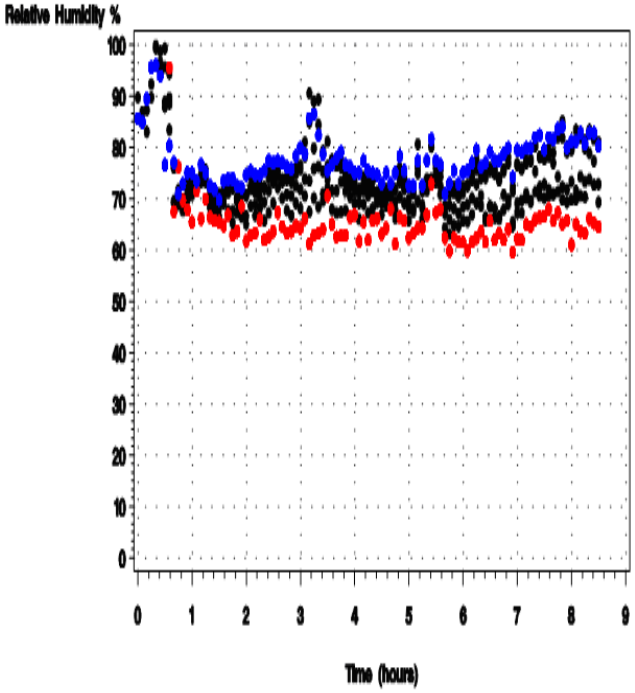
Relative humidity over time during winter transports

Logger in F1L/H1L **Logger in F3U/H3U** **Rest of loggers** **Outdoor logger**

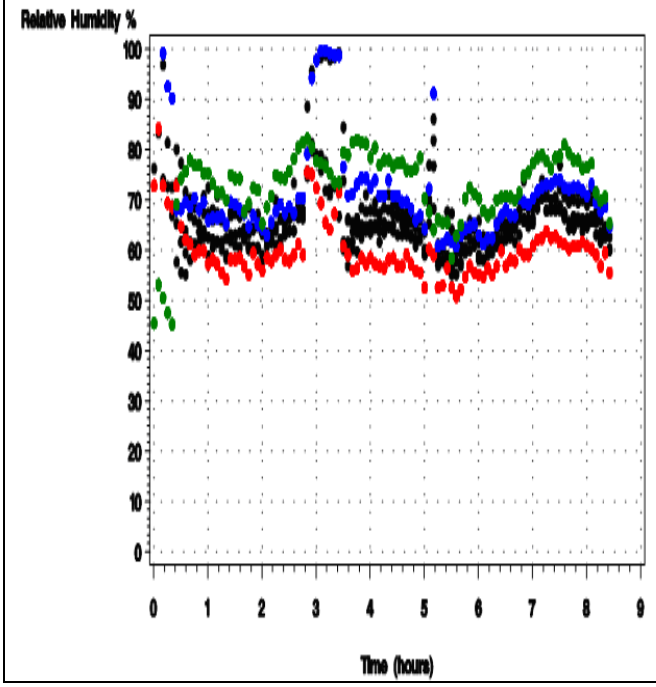
Fore-carriage – Repetition No 1



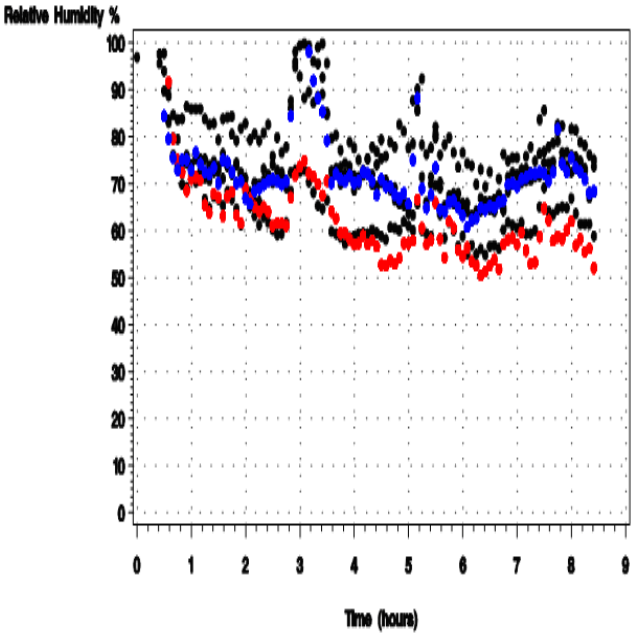
Hanger – Repetition No 1



Fore-carriage – Repetition No 2



Hanger – Repetition No 2

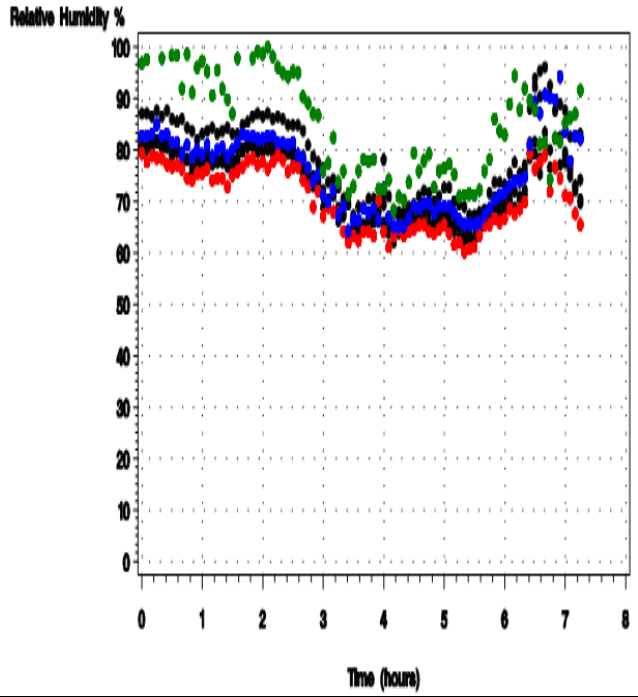
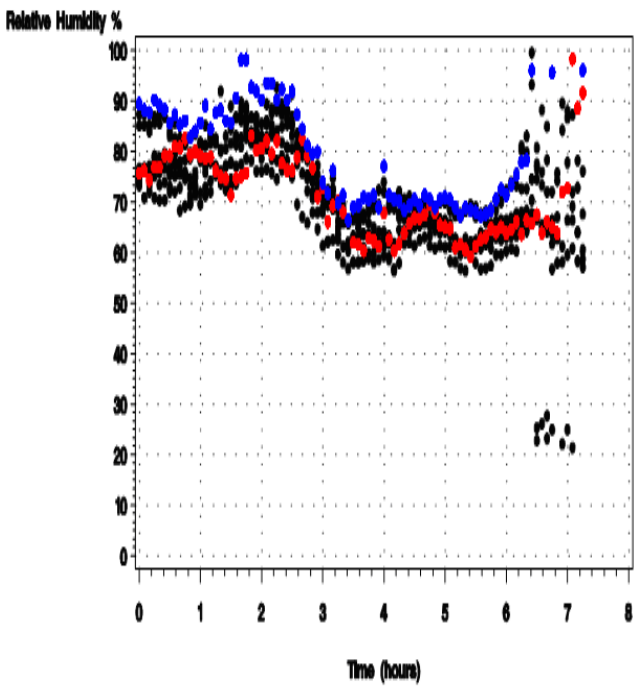
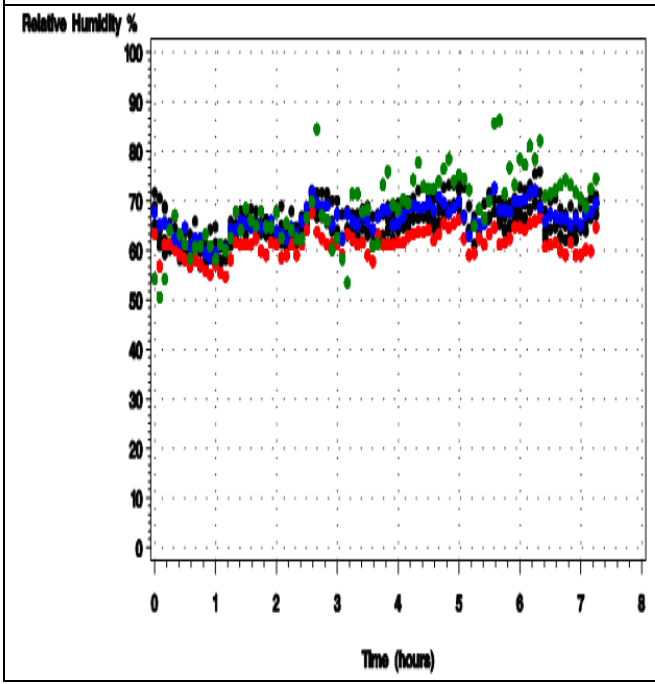
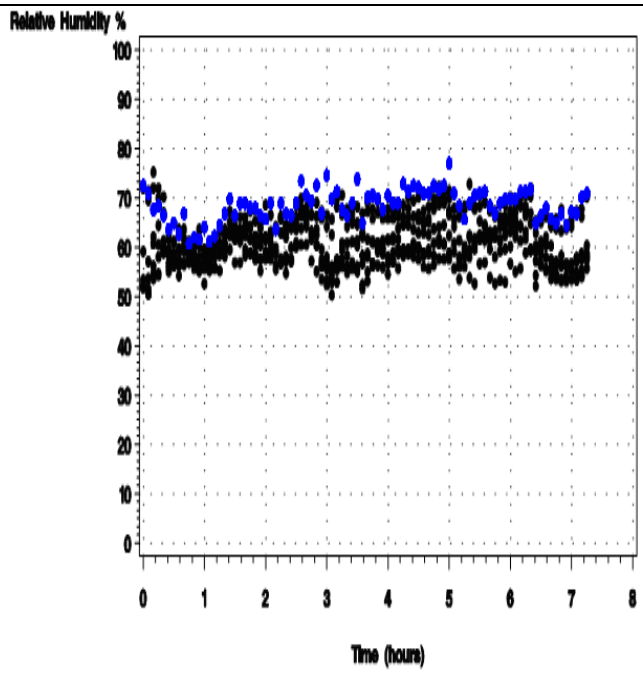


Attachment 13

Slaughter pigs

Relative humidity over time during summer transports

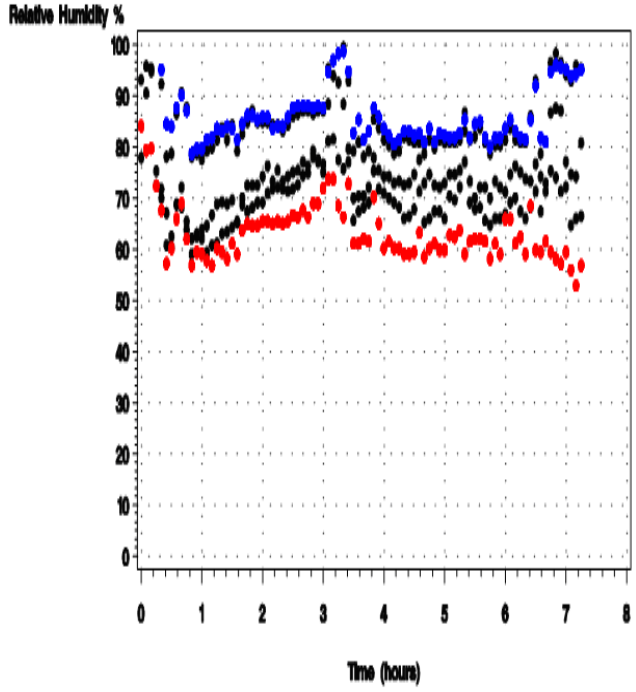
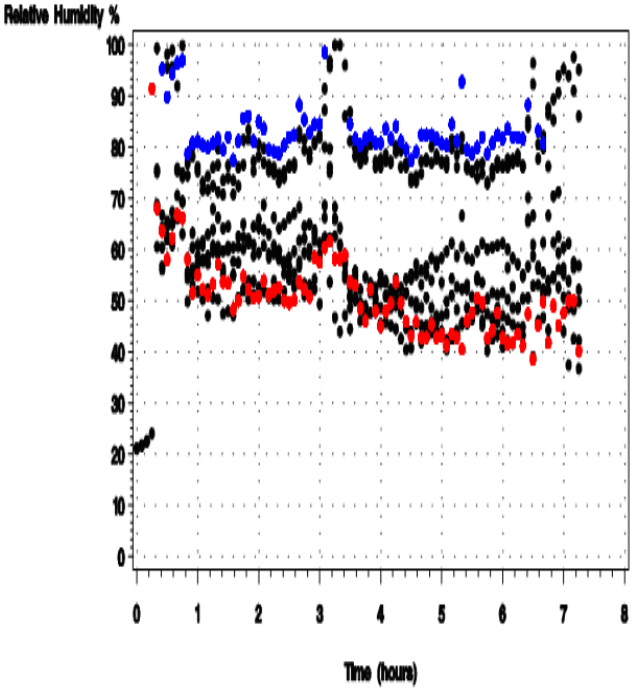
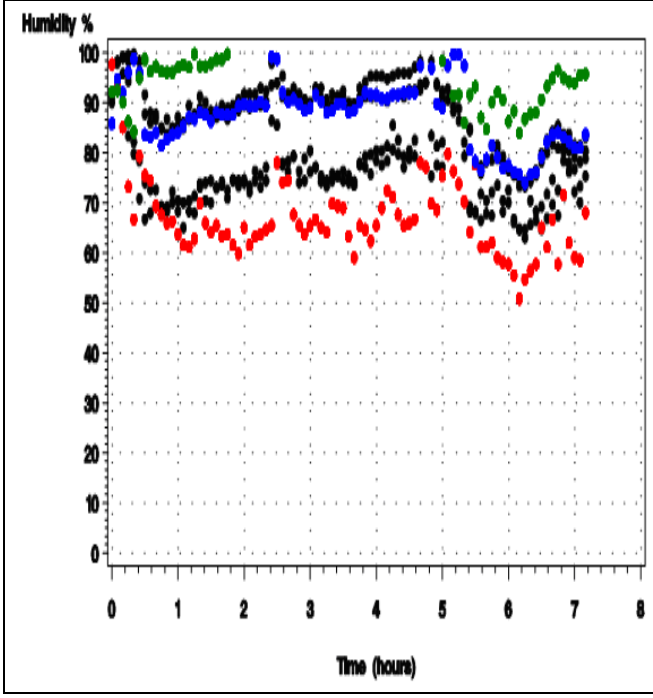
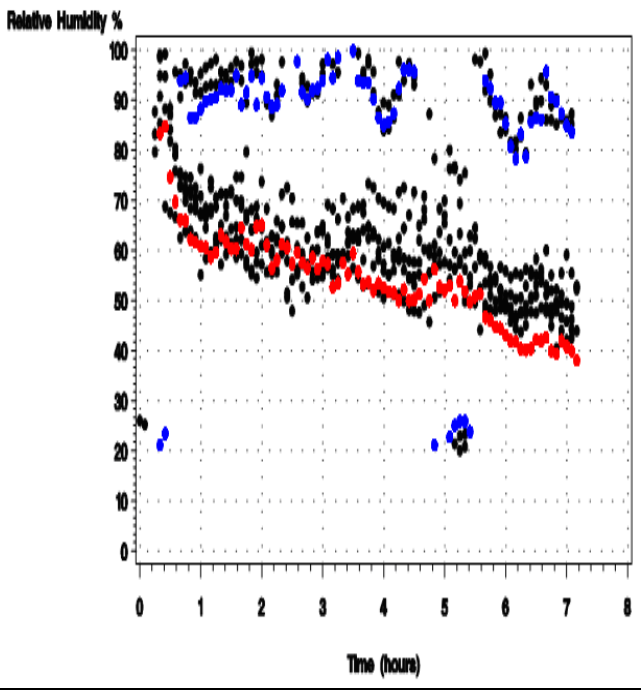
O **Logger in F1L/H1L** O **Logger in F3U/H3U** O **Rest of loggers** O **Outdoor logger**

Fore-carriage – Repetition No 1	Hanger – Repetition No 1
	
Fore-carriage – Repetition No 2	**Hanger – Repetition No 2**
	

Slaughter pigs

Relative humidity over time during winter transports

Logger in F1L/H1L **Logger in F3U/H3U** **Rest of loggers** **Outdoor logger**

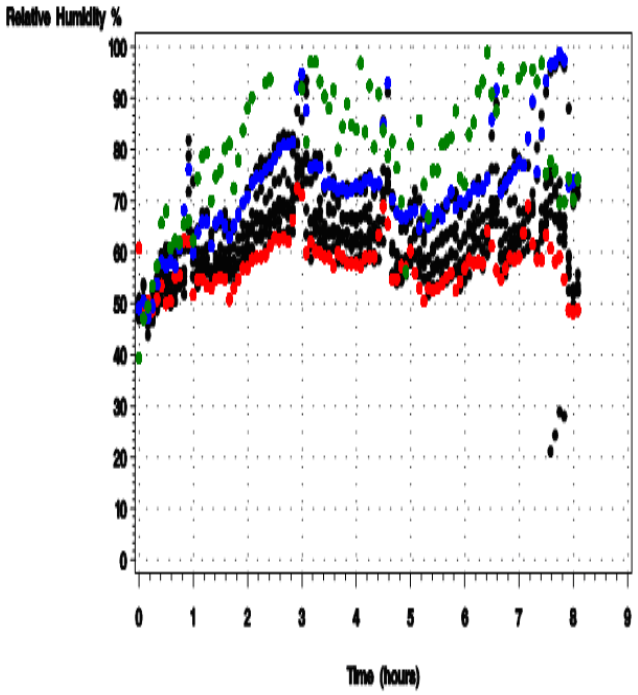
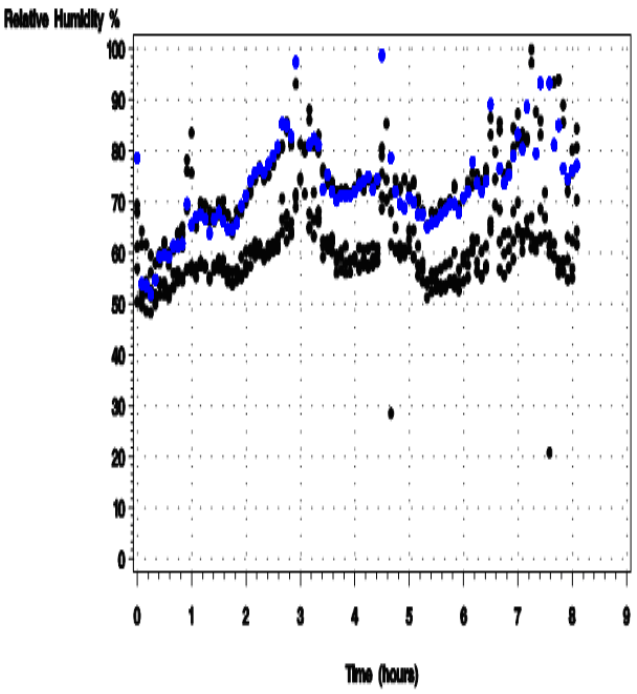
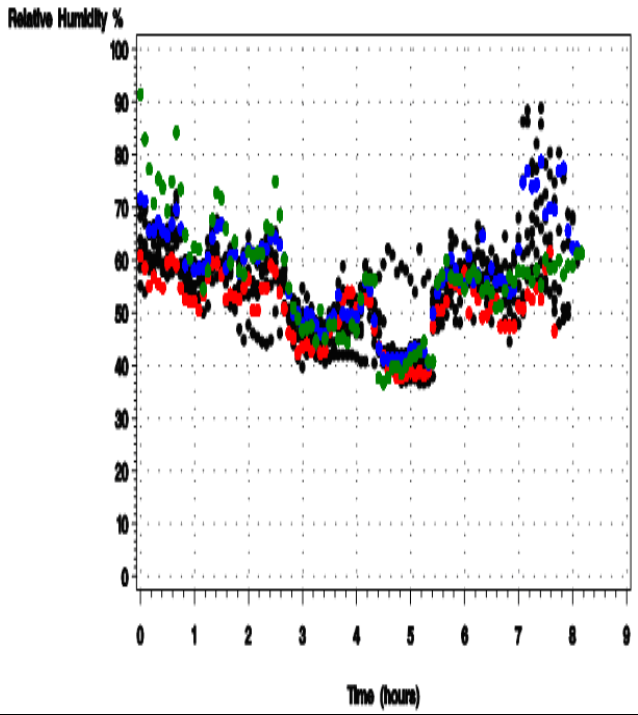
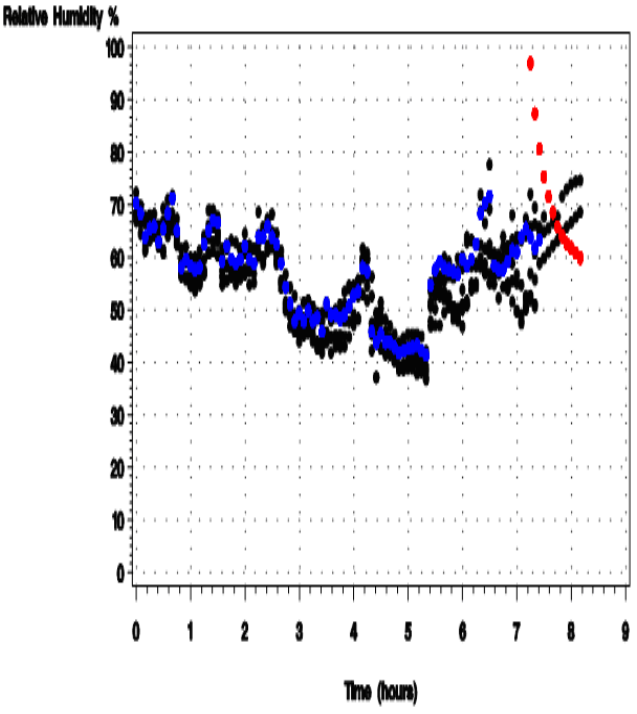
Fore-carriage – Repetition No 1	Hanger – Repetition No 1
	
Fore-carriage – Repetition No 2	**Hanger – Repetition No 2**
	

Attachment 14

Piglets

Relative humidity over time during summer transports

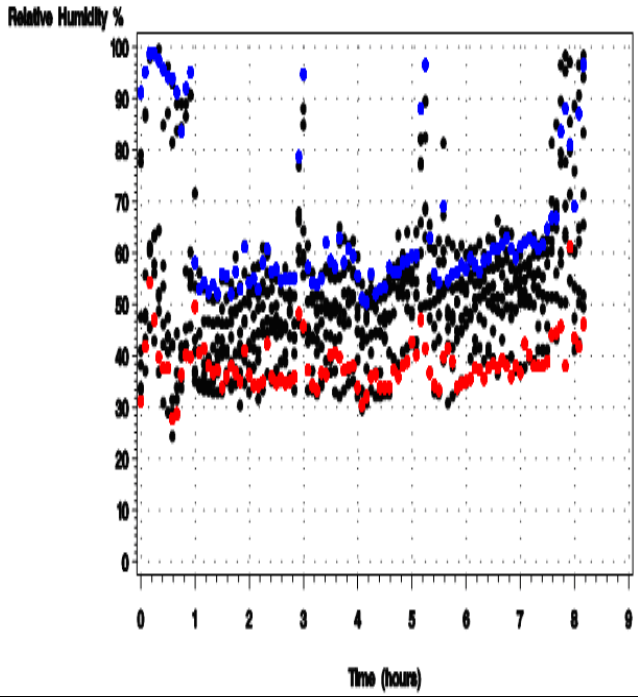
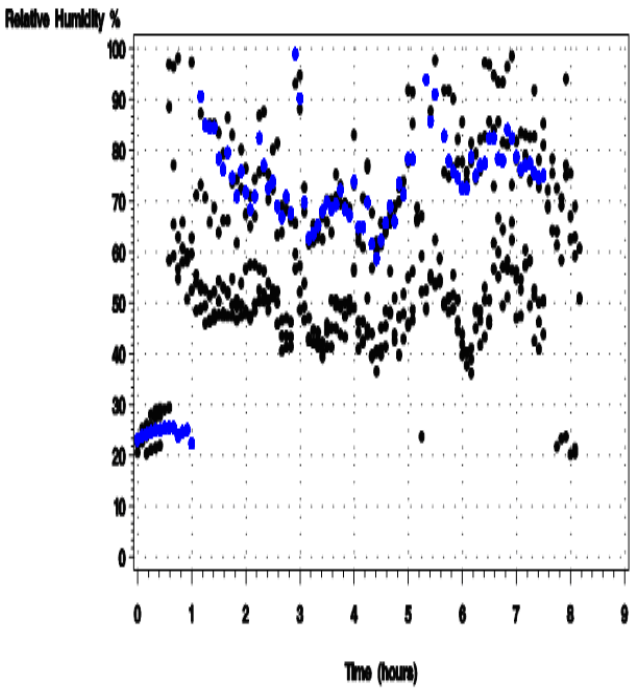
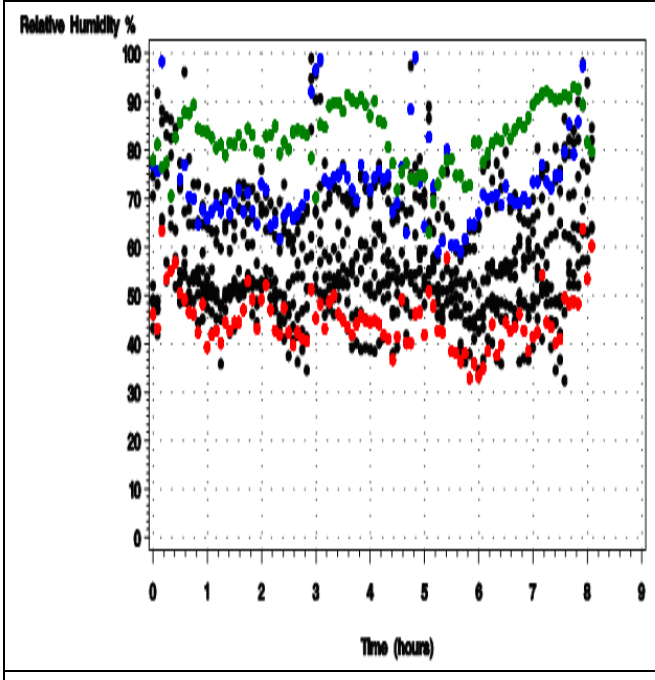
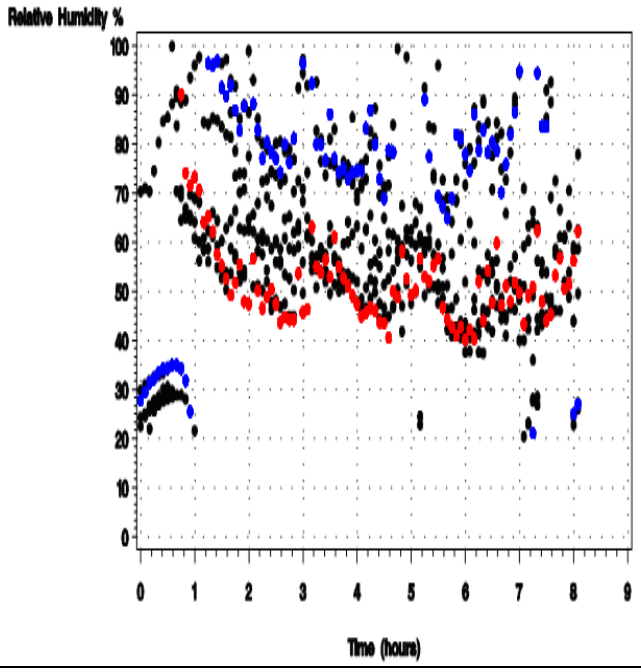
O **Logger in F1L/H1L** O **Logger in F3U/H3U** O **Rest of loggers** O **Outdoor logger**

Fore-carriage – Repetition No 1	Hanger – Repetition No 1
	
Fore-carriage – Repetition No 2	**Hanger – Repetition No 2**
	

Piglets

Relative humidity over time during winter transports

O Logger in F1L/H1L **O Logger in F3U/H3U** **O Rest of loggers** **O Outdoor logger**

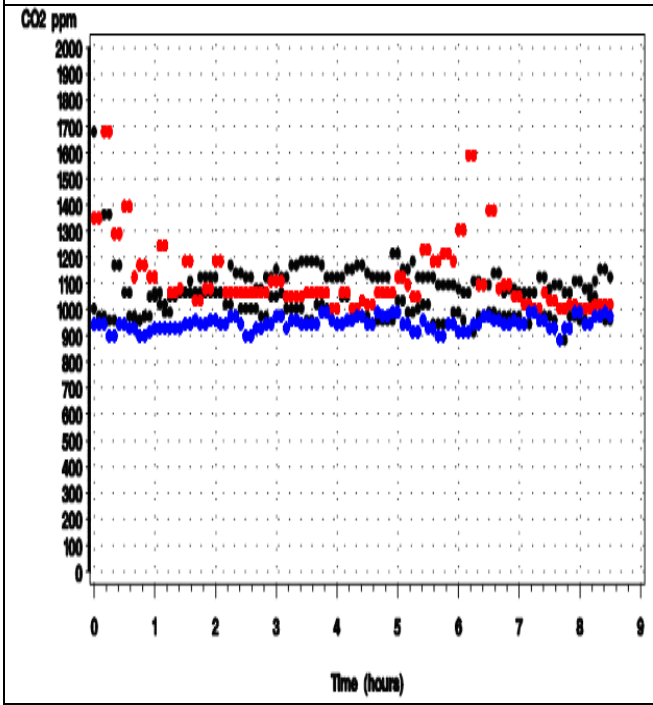
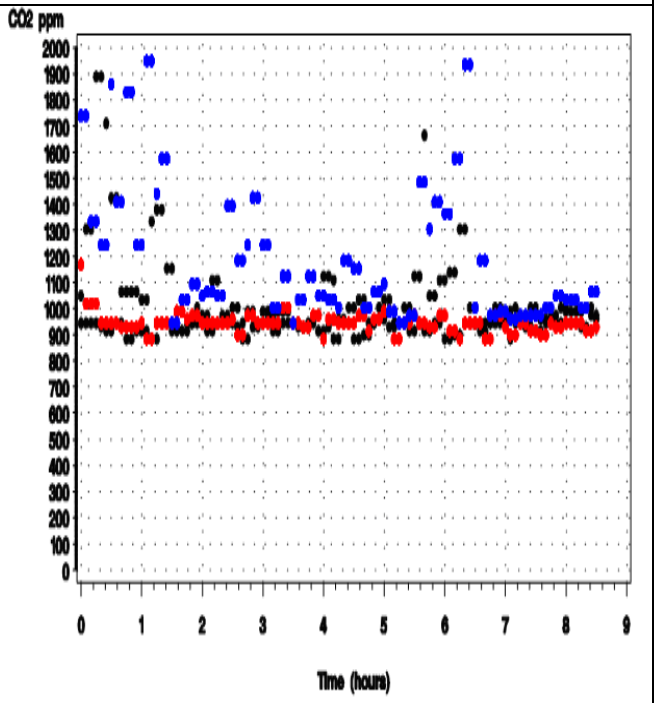
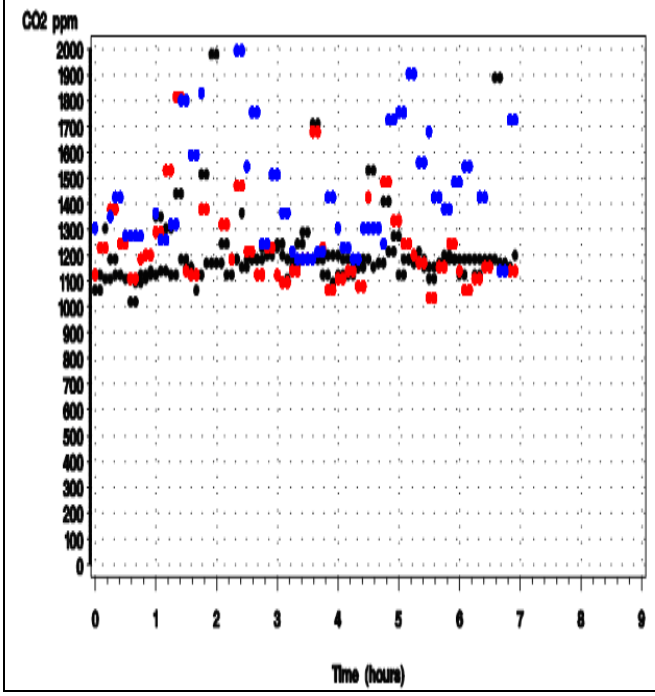
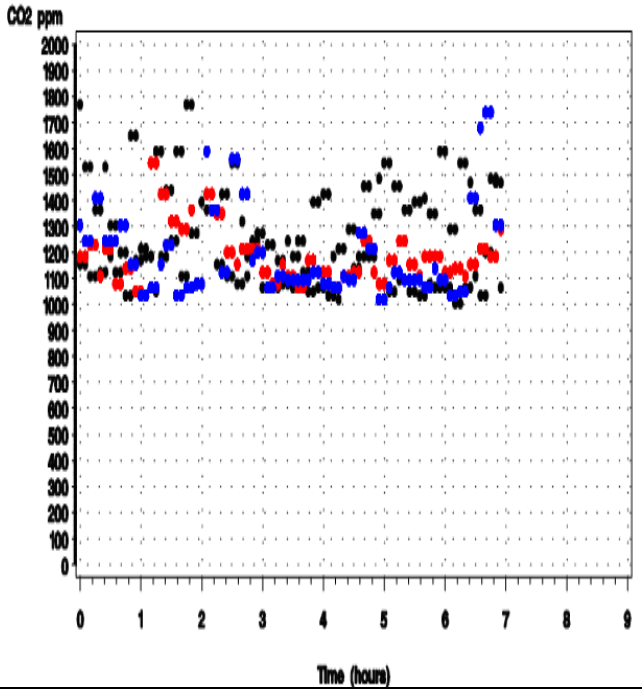
Fore-carriage – Repetition No 1	Hanger – Repetition No 1
	
Fore-carriage – Repetition No 2	**Hanger – Repetition No 2**
	
Time (hours)	Time (hours)

Attachment 15

Sows

CO^2 measurements over time during summer transports

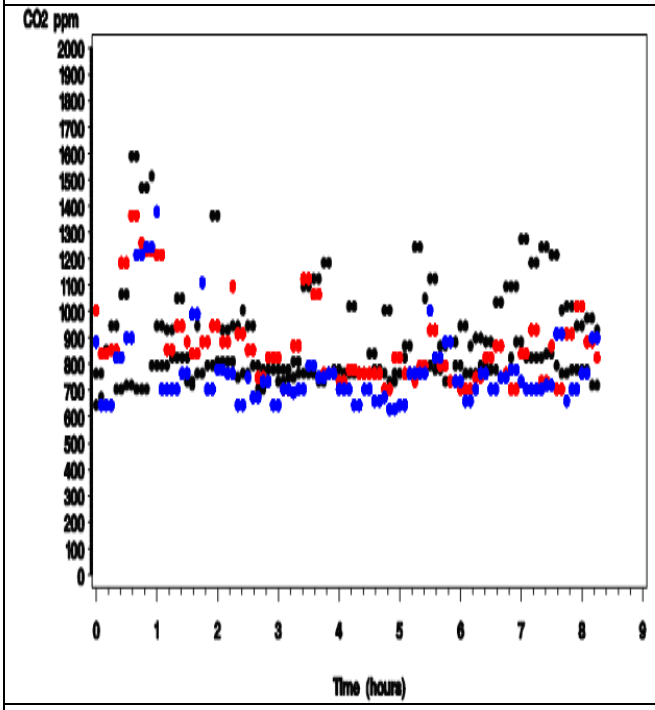
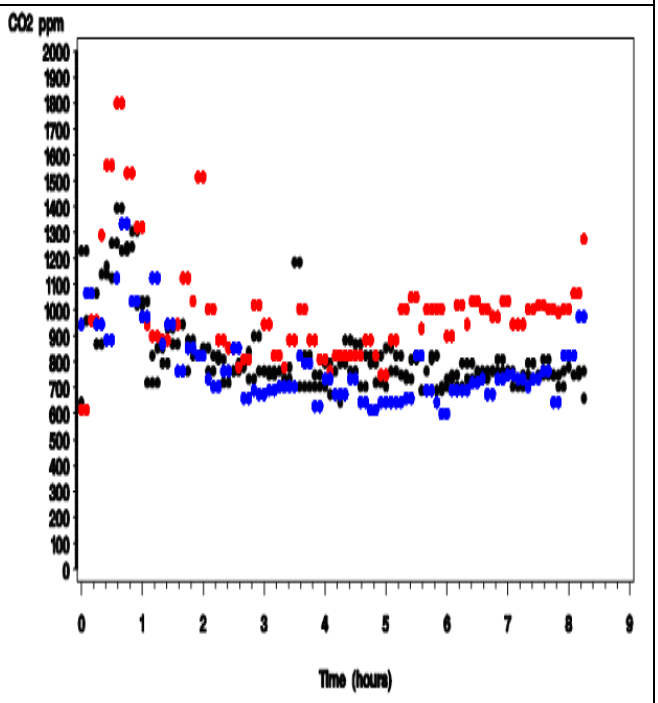
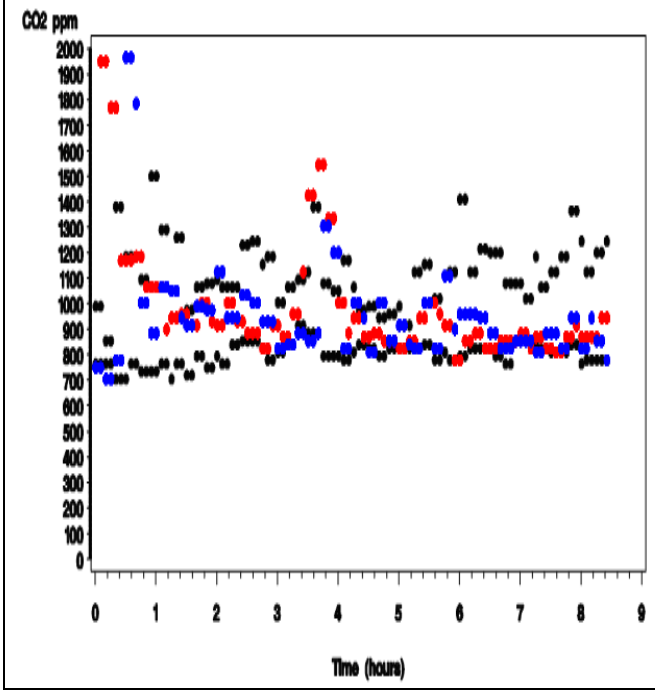
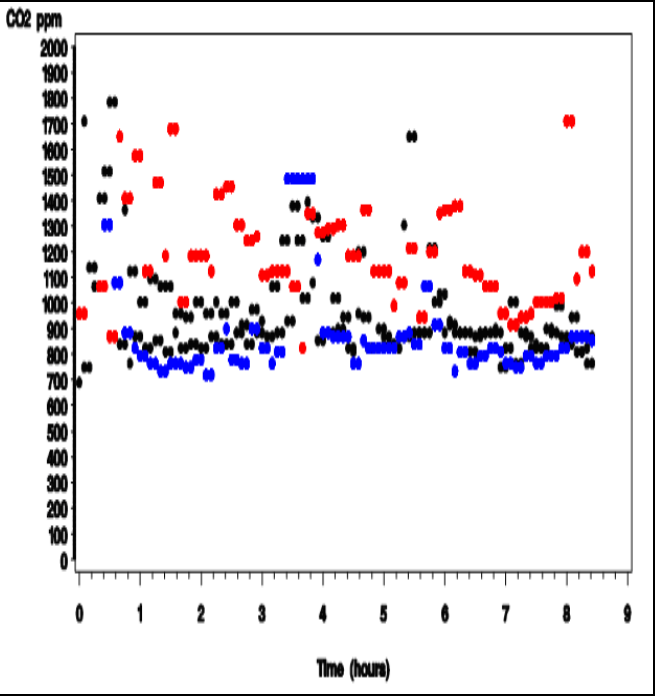
O Logger in F1L/H1L **O Logger in F3U/H3U** **O Rest of loggers**

Fore-carriage – Repetition No 1	Hanger – Repetition No 1
	
Fore-carriage – Repetition No 2	**Hanger – Repetition No 2**
	

Sows

CO^2 measurements over time during winter transports

O Logger in F1L/H1L **O Logger in F3U/H3U** **O Rest of loggers**

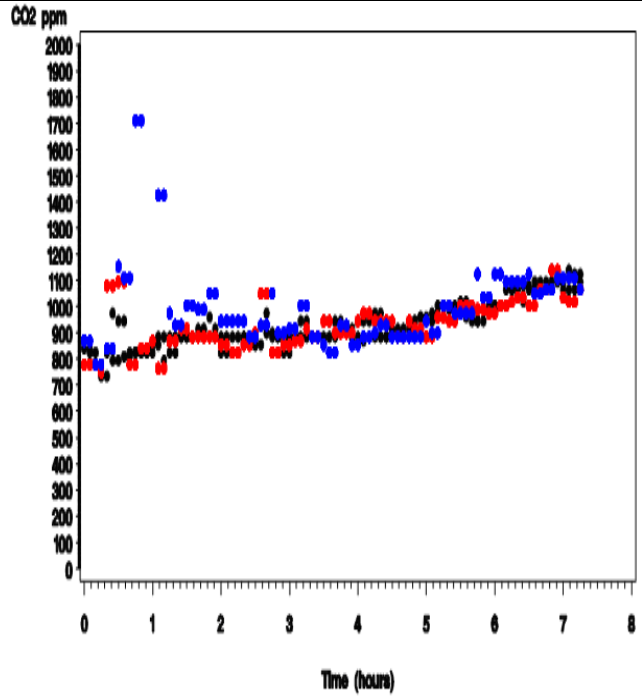
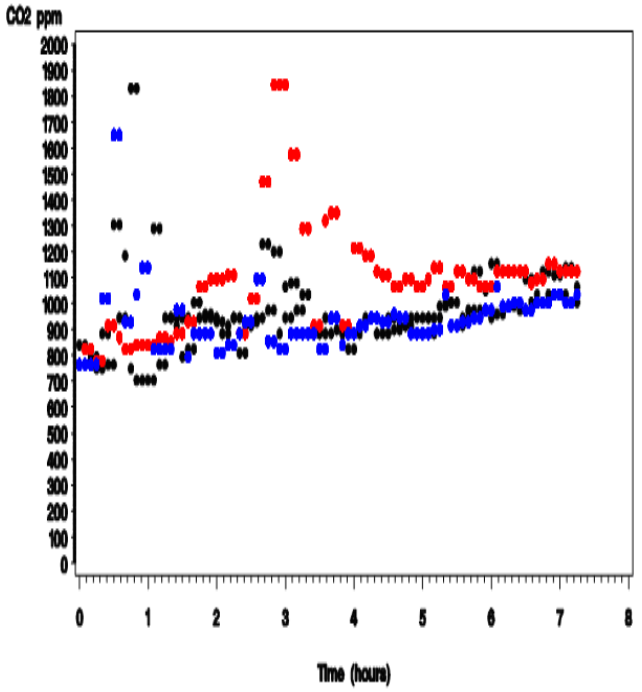
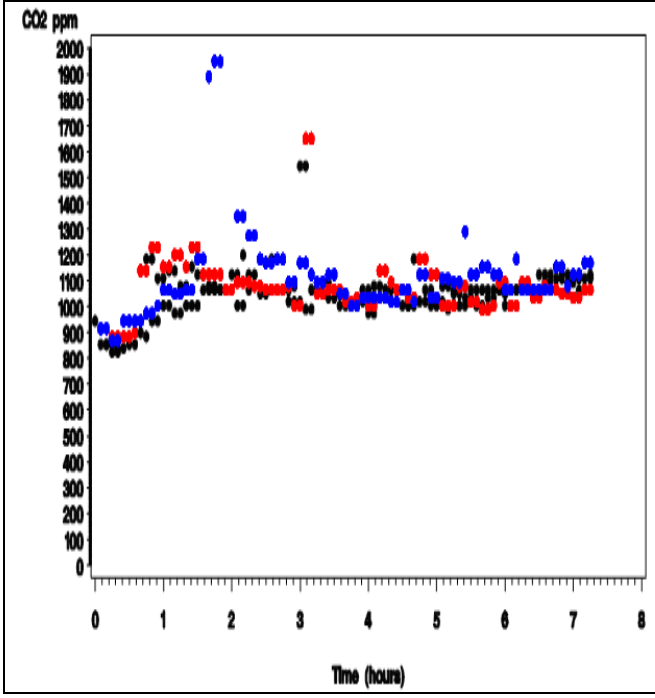
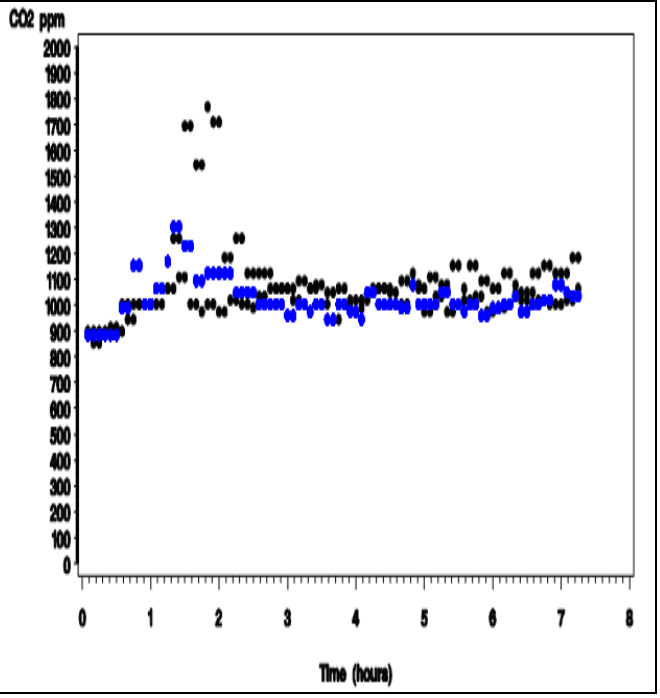
Fore-carriage – Repetition No 1	Hanger – Repetition No 1
	
Fore-carriage – Repetition No 2	**Hanger – Repetition No 2**
	

Attachment 16

Slaughter pigs

CO_2 measurements over time during summer transports

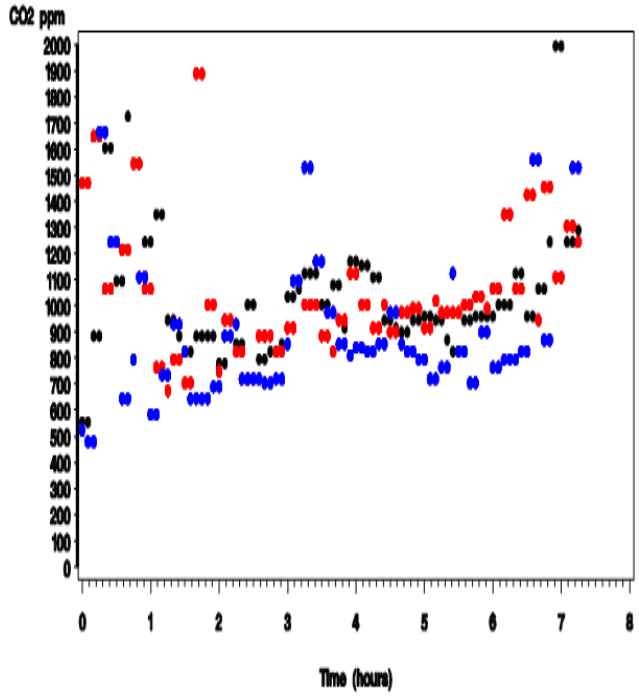
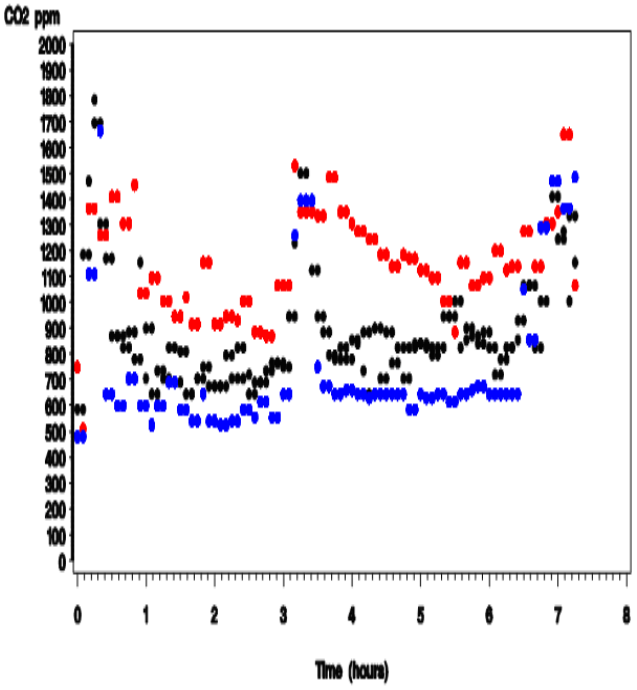
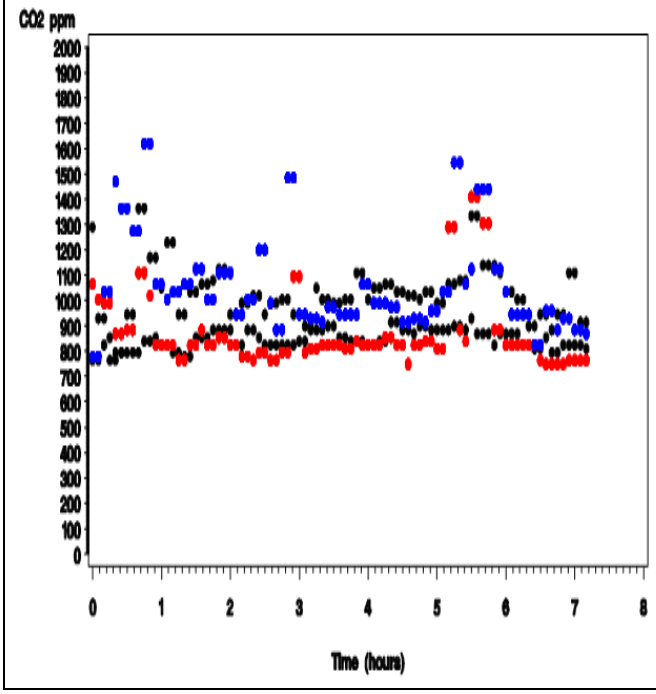
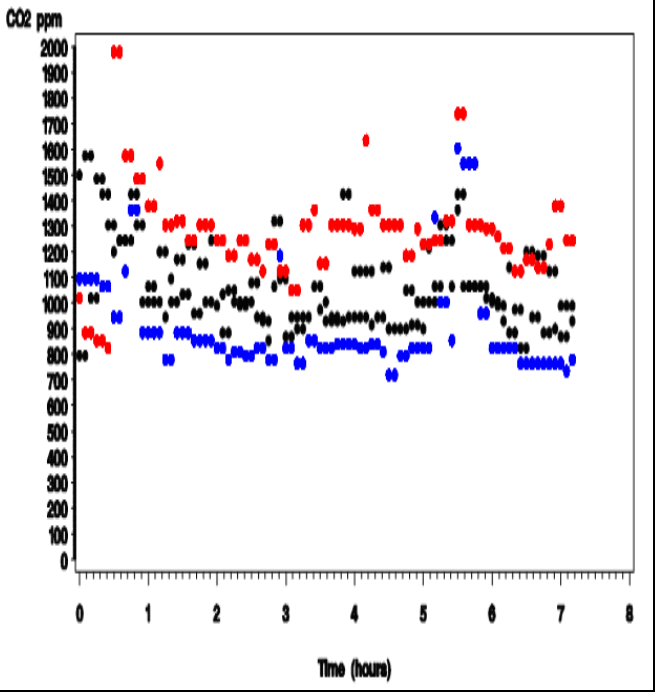
O Logger in F1L/H1L **O Logger in F3U/H3U** **O Rest of loggers**

Fore-carriage – Repetition No 1	Hanger – Repetition No 1
	
Fore-carriage – Repetition No 2	**Hanger – Repetition No 2**
	

Slaughter pigs

CO_2 measurements over time during winter transports

O Logger in F1L/H1L **O Logger in F3U/H3U** **O Rest of loggers**

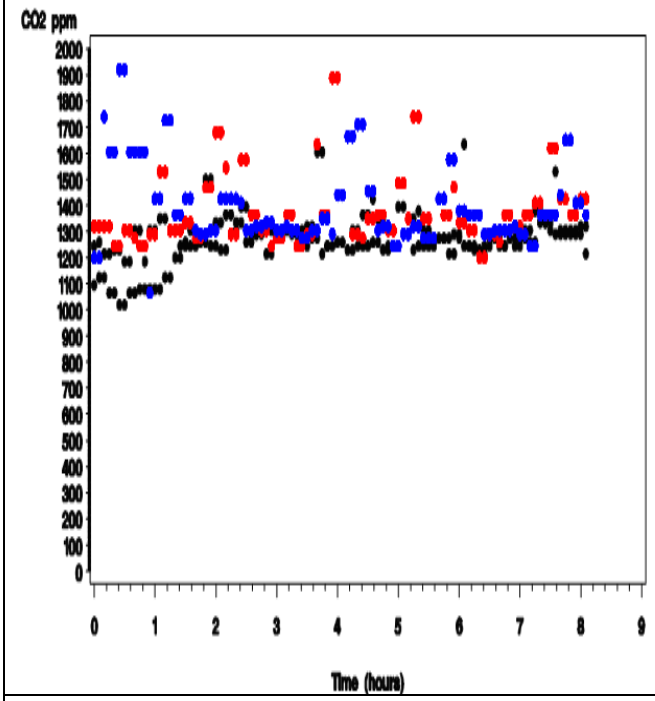
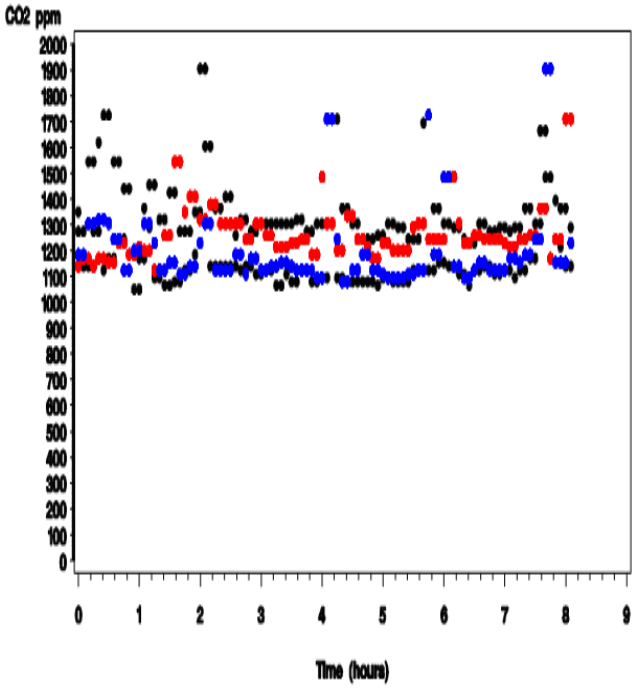
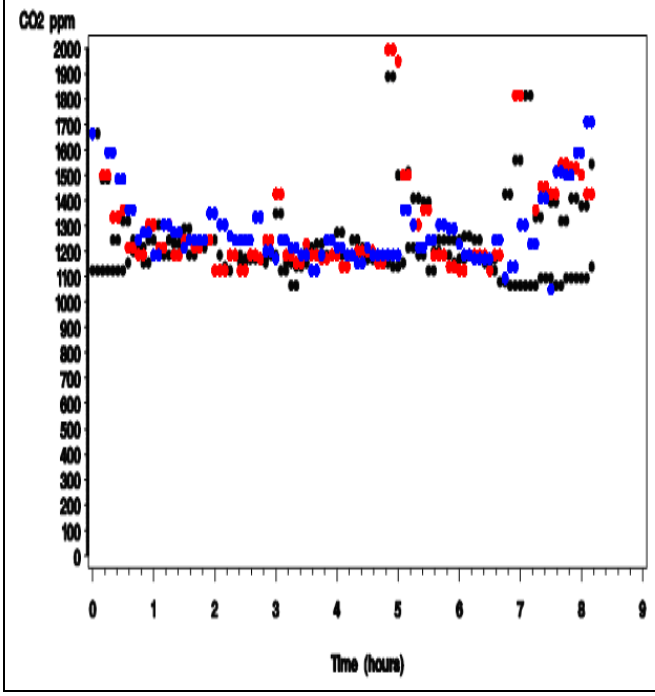
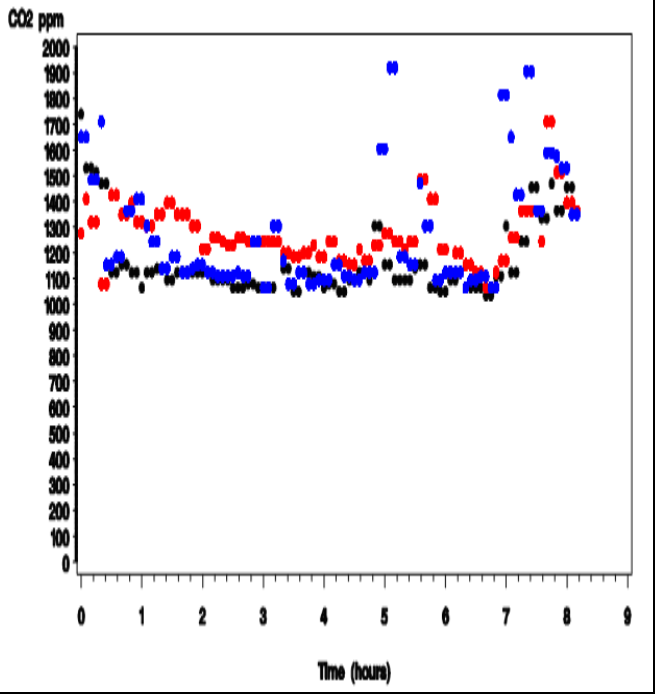
Fore-carriage – Repetition No 1	Hanger – Repetition No 1
	
Fore-carriage – Repetition No 2	**Hanger – Repetition No 2**
	

Attachment 17

Piglets

CO^2 measurements over time during summer transports

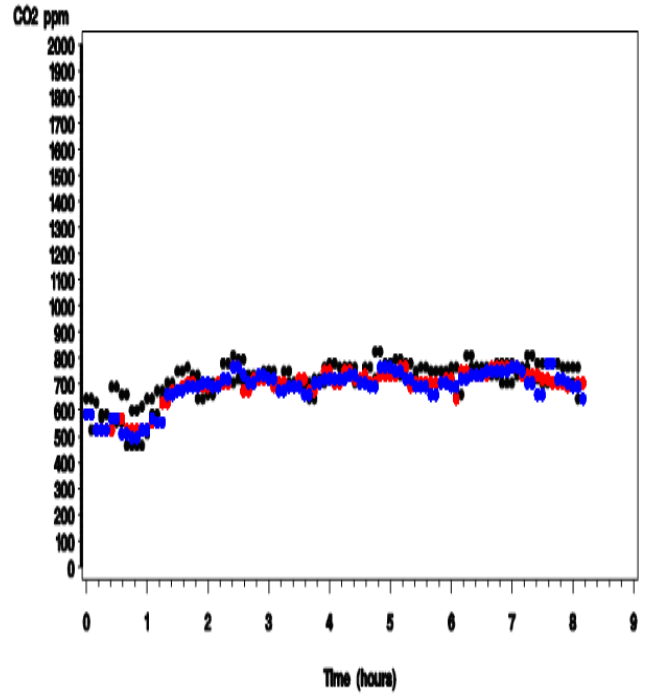
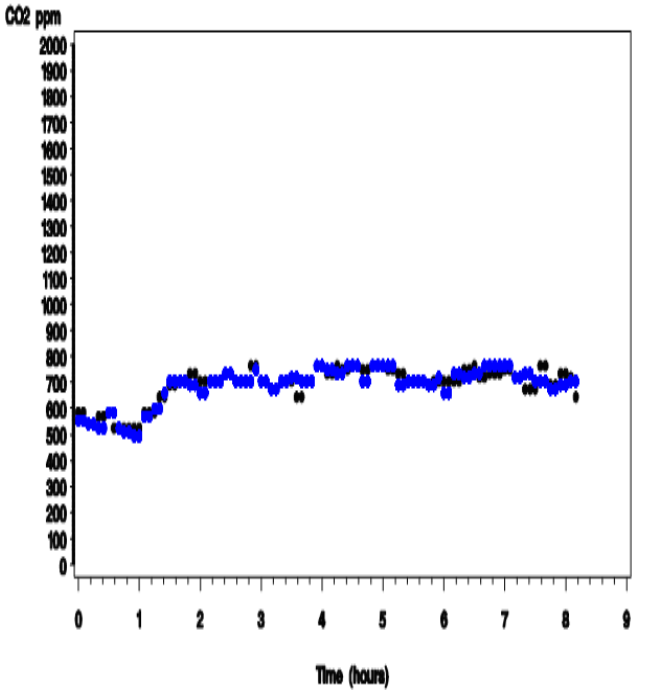
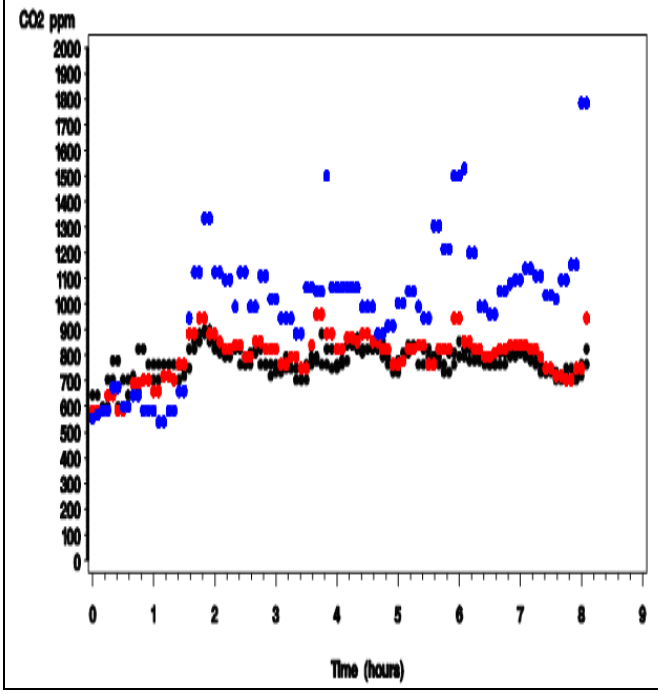
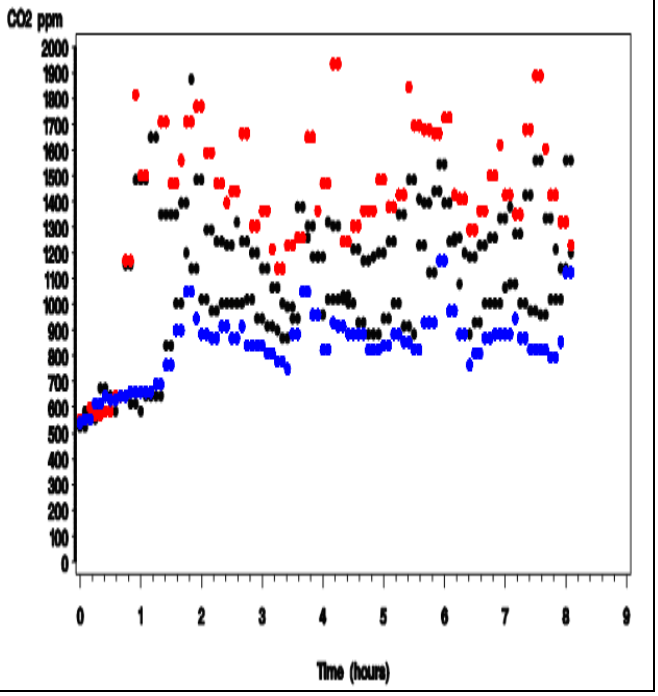
O Logger in F1L/H1L **O Logger in F3U/H3U** **O Rest of loggers**

Fore-carriage – Repetition No 1	Hanger – Repetition No 1
	
Fore-carriage – Repetition No 2	**Hanger – Repetition No 2**
	

Piglets

CO_2 measurements over time during winter transports

Logger in F1L/H1L **Logger in F3U/H3U** **Rest of loggers**

Fore-carriage – Repetition No 1	Hanger – Repetition No 1
	
Fore-carriage – Repetition No 2	**Hanger – Repetition No 2**
	

Heart rate for slaughter pigs on for-carrier during summer: 6th and 7th September 2006 Attachment 18

<table>
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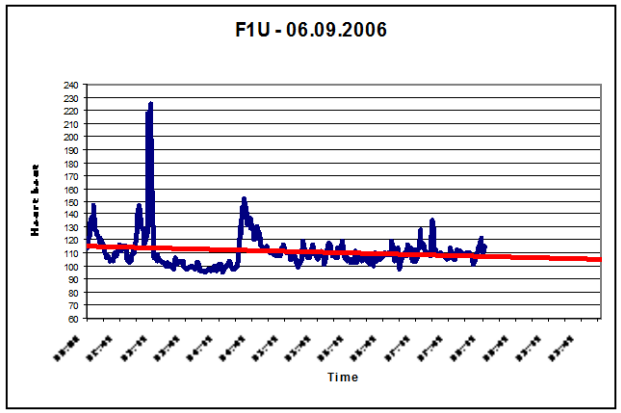
<td> 
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<td>F2U

No satisfactory heart rate has been monitored</td>
<td>F3U

No satisfactory heart rate has been monitored</td>
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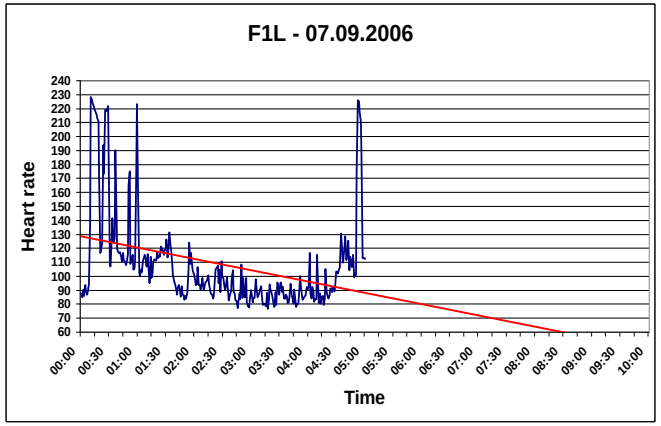
<td> 
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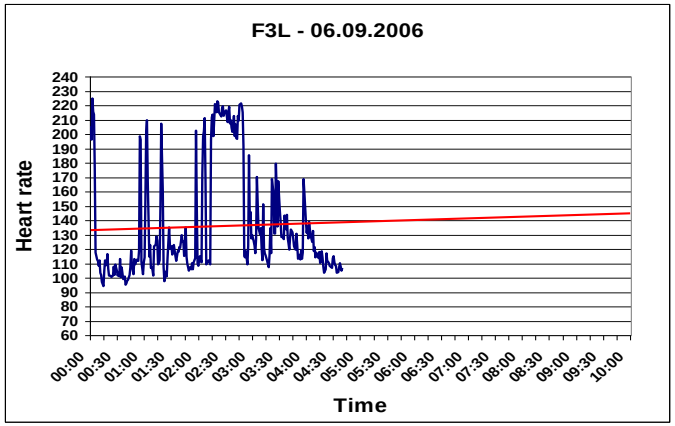
<td> 
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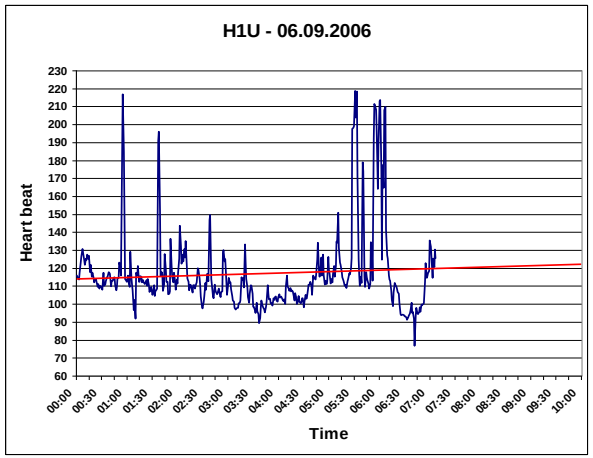
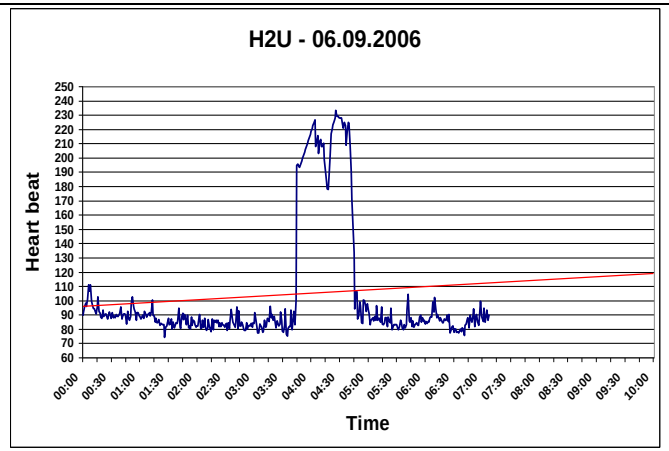
F = Fore-carrier
1 = 1st room situated closest to the drivers cabin
2 = 2nd room situated in the middle of the body of the carriage 3 = 3rd room situated in the rear of the carriage
U = Upper deck
L = lower deck

Heart rate for slaughter pigs on hanger during summer: 6th and 7th September 2006 Attachment 19

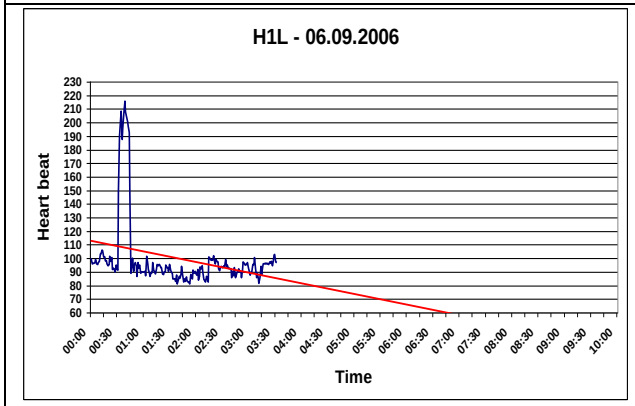




H3U

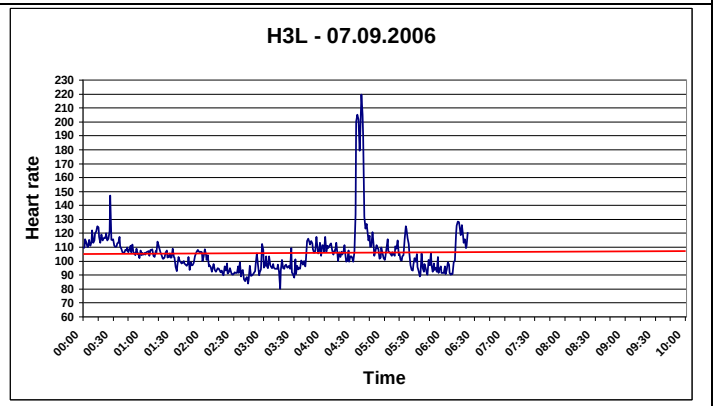
No satisfactory heart rate has been monitored

Heart rate registrations has not been carried out on the middle deck



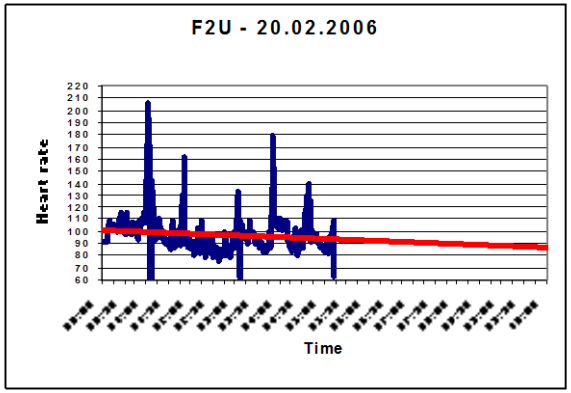
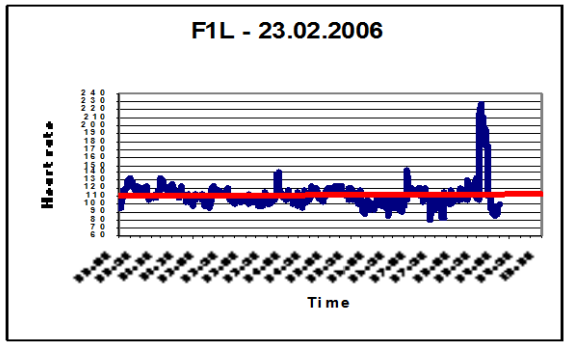
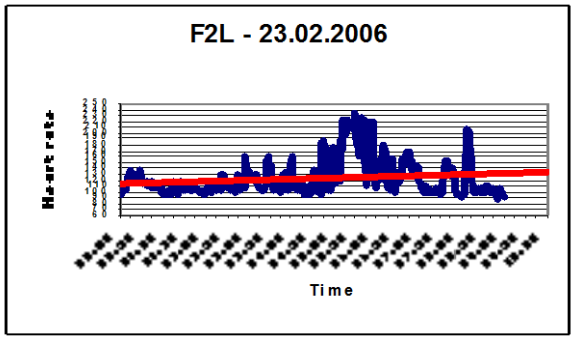
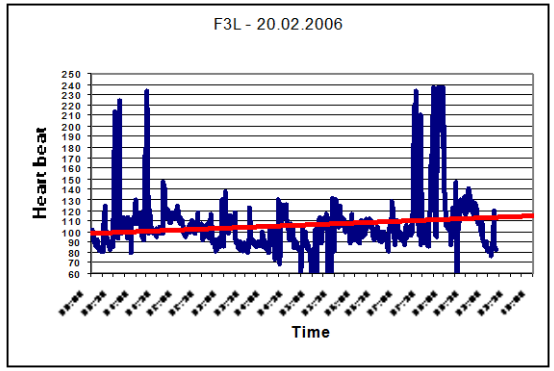
H2L

No satisfactory heart rate has been monitored



H = Hanger
1 = 1st room situated closest to the drivers cabin
2 = 2nd room situated in the middle of the body
3 = 3rd room situated in the rear of the body
U = Upper deck
L = lower deck

Heart rate for slaughter pigs on for-carrier during winter: 20th and 23rd February 2006 Attachment 20

F1U **No satisfactory heart rate has been monitored**		**F3U** **No satisfactory heart rate has been monitored**
		

F = Fore-carrier
1 = 1st room situated closest to the drivers cabin
U = Upper deck

2 = 2nd room situated in the middle of the body of the carriage
L = lower deck

3 = 3rd room situated in the rear of the carriage

Heart rate for slaughter pigs on hanger during winter: 20th and 23rd February 2006

Attachment 21

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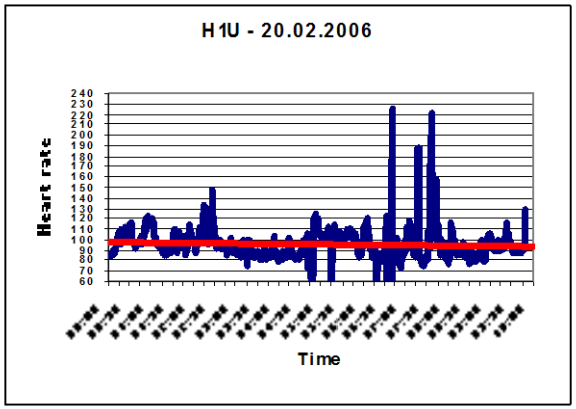
<td> 
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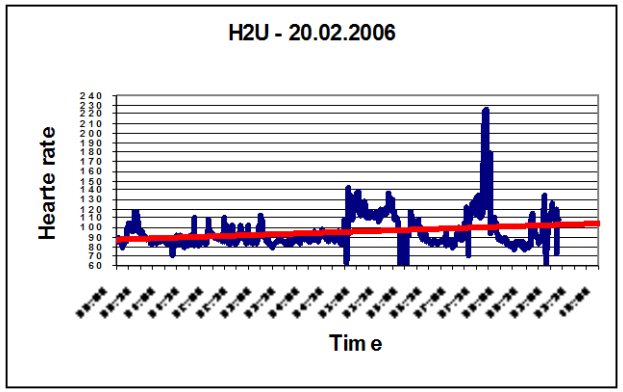
<td> 
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<td>H3U

No satisfactory heart rate has been monitored</td>
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<tr>
<td></td>
<td>Heart rate registrations has not been carried out on the middle deck</td>
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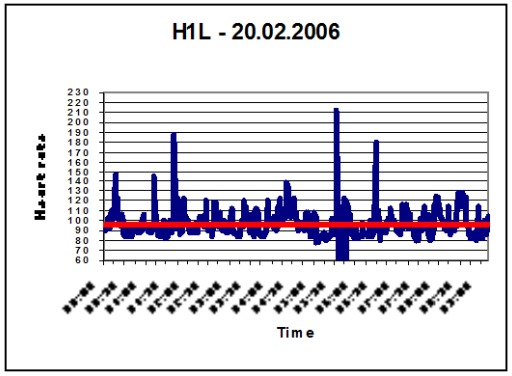
<td> 
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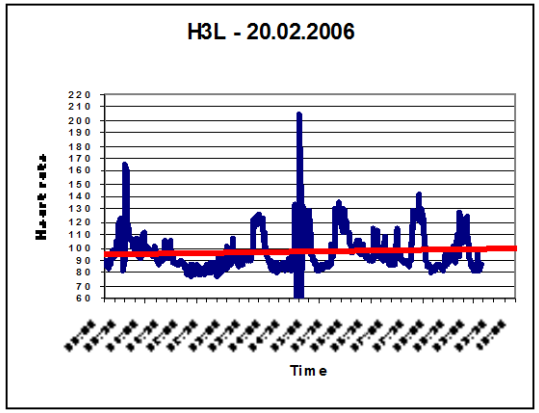
<td>H2L

No satisfactory heart rate has been monitored</td>
<td> 
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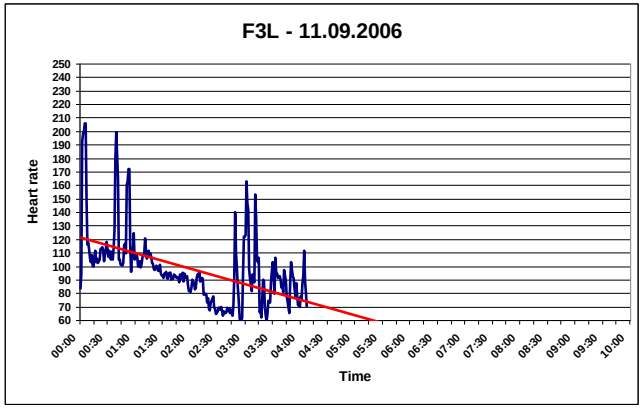
H = Hanger
1 = 1st room situated closest to the drivers cabin
U = Upper deck

2 = 2nd room situated in the middle of the body
L = lower deck

3 = 3rd room situated in the rear of the body

Heart rate for sows on for-carrier during summer: 11th and 12th September 2006

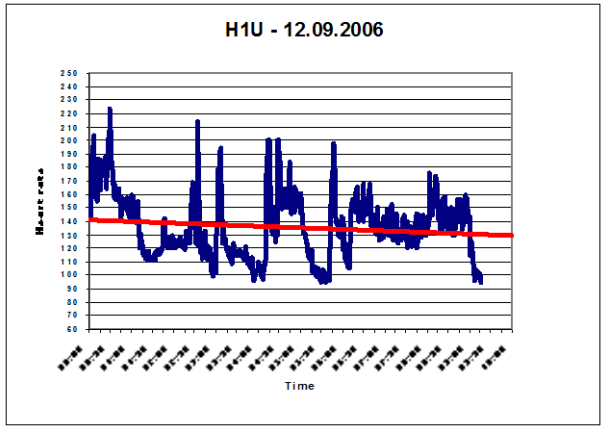
Attachment 22

F1U	F2U	F3U
No satisfactory heart rate has been monitored	**No satisfactory heart rate has been monitored**	**No satisfactory heart rate has been monitored**
F1U	**F2L**	
No satisfactory heart rate has been monitored	**No satisfactory heart rate has been monitored**	

F = Fore-carrier
1 = 1st room situated closest to the drivers cabin
2 = 2nd room situated in the middle of the body of the carriage
3 = 3rd room situated in the rear of the carriage
U = Upper deck
L = lower deck

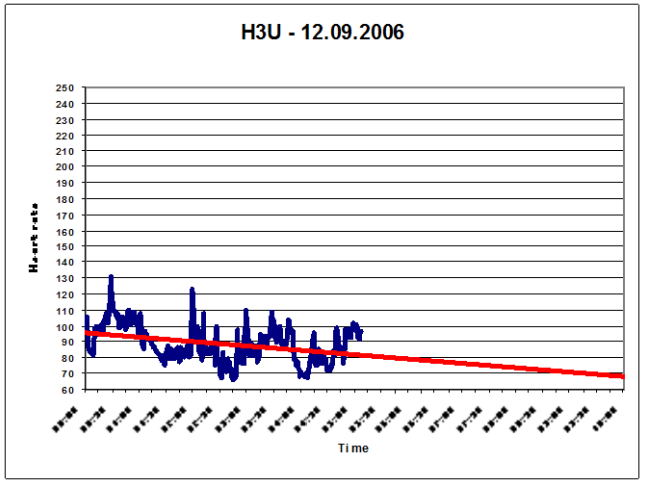
Heart rate for sows on hanger during summer: 11th and 12th September 2006

Attachment 23



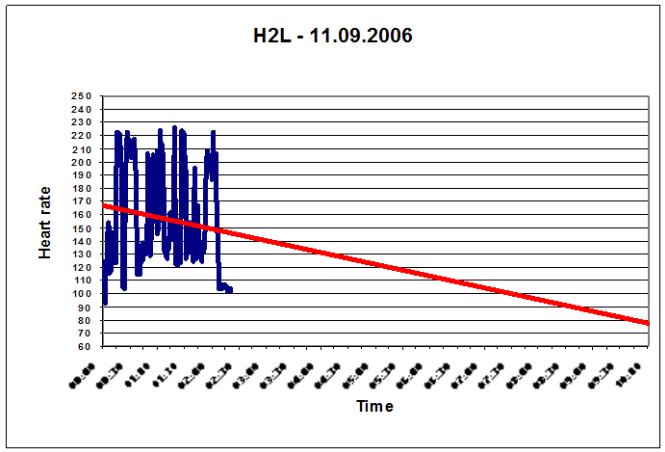
H2U

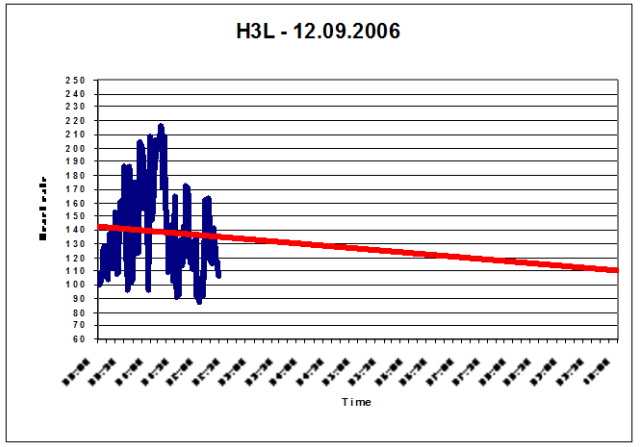
No satisfactory heart rate has been monitored



H1U

No satisfactory heart rate has been monitored

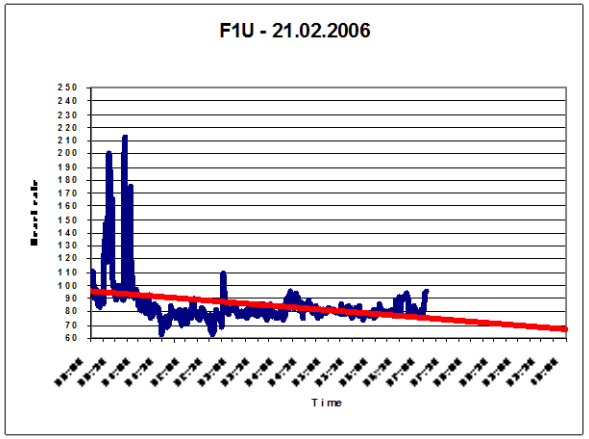


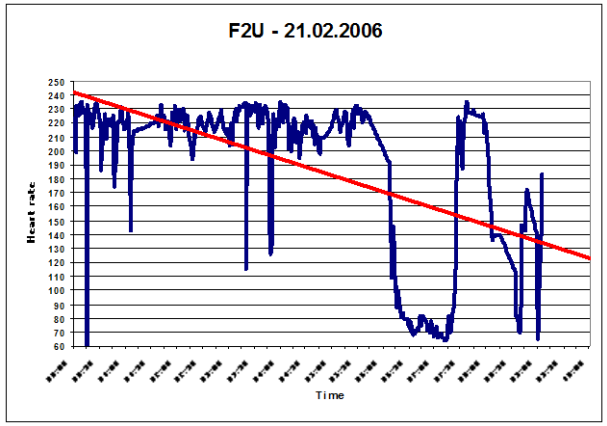


H = Hanger
1 = 1st room situated closest to the drivers cabin
2 = 2nd room situated in the middle of the body
3 = 3rd room situated in the rear of the body
U = Upper deck
L = lower deck

Heart rate for sows on for-carrier during winter: 21st and 22nd February 2006

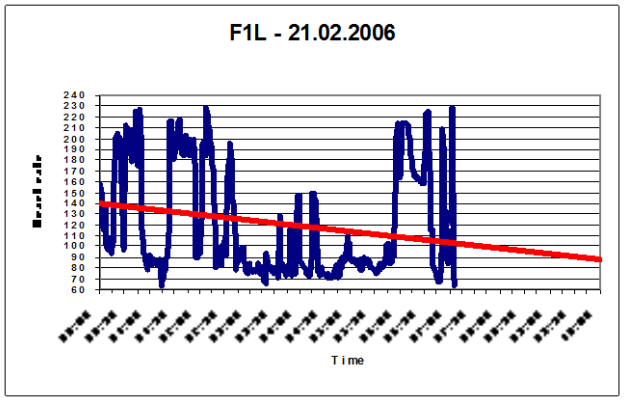
Attachment 24

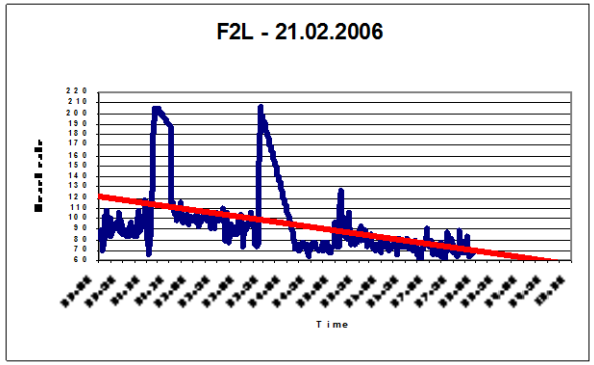


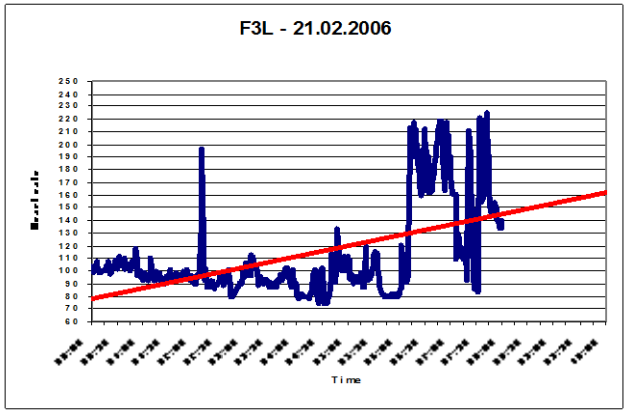


F3U

No satisfactory heart rate has been monitored







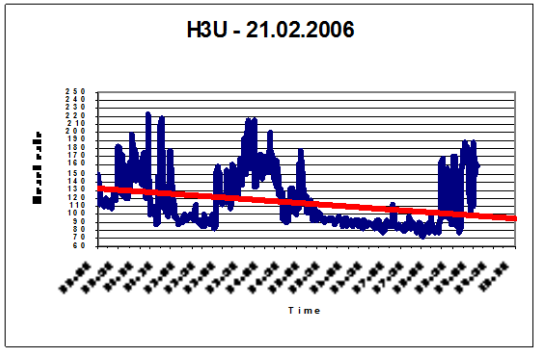
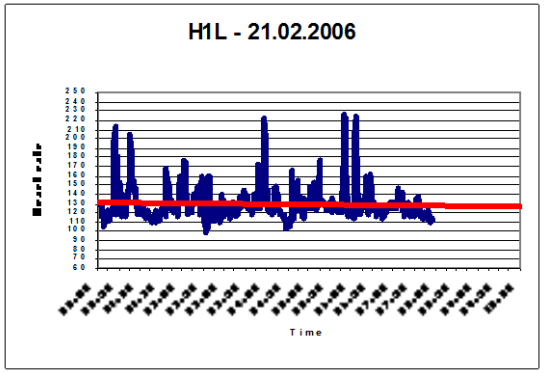
F = Fore-carrier
1 = 1st room situated closest to the drivers cabin
U = Upper deck

2 = 2nd room situated in the middle of the body of the carriage
L = lower deck

3 = 3rd room situated in the rear of the carriage

Heart rate for sows on hanger during winter: 21st and 22nd February 2006

Attachment 25

H1U **No satisfactory heart rate has been monitored**	**H2U** **No satisfactory heart rate has been monitored**	
	**H2L** **No satisfactory heart rate has been monitored**	**H3L** **No satisfactory heart rate has been monitored**

H = Hanger
1 = 1st room situated closest to the drivers cabin
U = Upper deck

2 = 2nd room situated in the middle of the body
L = lower deck

3 = 3rd room situated in the rear of the body