SUMMARY

In Sweden, around 3.5 million pigs are transported yearly from farms to abattoirs. Under the entire transport chain from the pens in the pig house to the abattoir, the pigs will be exposed to the stresses caused by regrouping, a new environment in the truck, mechanical vibrations, noise, and especially during the summertime, an uncomfortable climate. Several investigations have also reported that these factors can cause important economic losses in the form of deaths and lowered carcass quality under unsuitable transport conditions. The combination of climatic impact, social regrouping, loading and the transportation movements means a stressful environment for the pigs. Under these conditions in Sweden, the summer months lead to a doubling in the mortality rate of transported pigs, as compared to that in other seasons. The main purpose of this project has been to improve the welfare of the animals (animal protection and health) during transport from farm to abattoir. Partial goals have been to:

1. Test and use existing methods and sensors for recording the outside and inside climate, vibrations during transport and relevant physiological parameters to assess the stress level of the pigs;
2. Make a survey of the climate in the truck, vibrations, pig social behaviour at loading and transport, and determine how these factors influence the welfare and health of the animals;
3. Obtain experience with the methodology chosen, and with studies of pigs in connection with loading and transport, in order to attain the necessary competence;
4. Work out suggestions for the design of transport vehicles to reduce stress during transport and thereby improve pig welfare.

A commercial pig farm in mid-Sweden delivering pigs every week in a standard transport vehicle (maximum loading capacity 100 pigs (115 kg) to the abattoir in Uppsala provided the animals and transport material for the present series of studies. Data was collected during seven trips from the end of July until the beginning of October, in 2003.

Three categories of data collections of observations of pigs and truck conditions were made:

- Biology (cortisol levels at slaughter), lesions (before and after transport, and after slaughter), behaviour (during transport)
- Climatic parameters in and outside the truck at loading, transport and unloading. Measurements of temperature, relative humidity, and CO₂ levels at different points in the upper and lower decks of the truck. Studies of air movement in the truck when driving without animals, before and after modification of ventilation openings.
- Vibrations were recorded in the truck during the transport of the pigs
Results
The pigs were loaded according to normal procedures early in the morning, and were then transported directly to the abattoir. Loading lasted 40 – 75 minutes. The drive lasted 60 – 70 minutes, and unloading 20 minutes. Trips 1-4 were done with the truck equipped with standard ventilation openings in the sides and roof, and the outside temperature was on average 21.0°C during these trips. Trips 5-7 were done with different modifications of the ventilation openings when driving; and the outside temperature was 15.1°C on average.
At loading, 10 pigs were selected for observation and for registering lesions before and after transport. Blood samples were taken for cortisol analysis at the bleeding station at slaughter. During all trips, the same number of pigs occupied the pen with the observation pigs, and video recordings were taken for behaviour studies during transport.

The pigs showed no difference in general behaviour pattern between the trips. However there were large differences between animals in the same trip. More panting was observed during trips 2-4 in comparison to trips 5-6. More pigs stood up during trips 5-7, than during trips 2-4.

The number of lesions on the animals increased during transport. On average, the “lesion score” increased 2.5-points for all the trips. There was a good agreement between the scoring after unloading and the scoring of the carcass. During trips (1-4) with the highest temperatures, the greatest number of stressed/cyanotic pigs were observed, and several pigs were in bad condition at the end of transport. The aggressive incidents and other actions that could be expected to cause injuries were almost only observed during loading. During transport, few aggressions were observed.

The cortisol samples showed that the negative effect of transport was the same for all the trips.

Thermal environment in the truck
There was a rapid increase in temperature, relative humidity and CO2 levels during loading. On average, the temperature increase was 0.15°C/min at loading when the air exchange was entirely dependent on the outer wind and natural ventilation due to gravity. The ventilation rate for the truck when standing still was estimated to be a maximum of 13 m³/pig and hour. The loading was done early in the morning, and the effect of solar radiation on the thermal environment in the truck could not be registered. Any contribution of heat load from the truck engine could not be found.

When driving, the ventilation increased and hence the temperature, relative humidity and CO2 levels decreased. Using data for heat and CO2 dissipation from the pigs, the ventilation rate was calculated to be 100 – 200 m³/pig and hour. The temperature differences between the inside and the outside of the truck were on average 1.5 – 2.0°C on arrival at the abattoir.

With standard ventilation openings (trips 1-4), the warmest locations in the truck were in the middle of the upper deck and in the most forward pen at the lower deck. The highest temperature difference measured within the truck was 3.4°C. Having the roof openings open forwards meant a very even temperature distribution in the upper deck.
In the lower deck, the temperature increase from the rear to the front of the truck was
accentuated. With frontal open roof louvers the temperature difference within the truck
was 4.1°C, due to the internal air movements in the truck. When driving, air exits the
truck from the ventilation openings along the sides in the most forward part, and entered
the truck from those towards the rear. The incoming air then moved in a very thin layer
along the wall. Installing an air guide in the ventilation opening meant a significant
increase in the air movement. The air exits at the back under those conditions.

More pigs showed sign of thermal stress (panting) at temperatures exceeding 25°C than
at 20°C. A relative humidity over 80 % enhanced the thermal stress at temperatures
above 21°C. Increasing the air velocity among the pigs at temperatures above 21°C
appeared to reduce the heat stress, although the behaviour studies gave no definite
answers about the reaction of the observed animals to the altered air currents.

High vibration levels (exceeding 0.3G) occurred which caused stress among the pigs.
However the acceptable level for vibration levels is not presently known for these
animals.

Conclusions and recommendations
The results show that both the social and the thermal stresses are at their highest at
loading and in the beginning of transport. General practice is often to regroup the pigs
in connection with loading. This should be avoided, and the grouping should preferably
be done some days prior to loading. The pens in the truck should contain a module of
the number of pigs going to be handled in the abattoir, so that a standard group can be
formed. These measures ought to reduce the lesions pigs acquire at loading and during
transport.

Ventilation (air exchange) and air movement among the animals when the truck is
standing still must be improved. It is not clarified whether natural ventilation at outside
temperatures above 18°C and with no wind blowing outside can provide sufficient
ventilation, or whether mechanical ventilation will be needed. The EU animal transport
directive proposal (2003) demands a minimum air flow of 60 m³/100 kg pig. Heat stress
at loading ought to be reduced with water sprinkling and forced air movements in the
loading pen and/or in the truck. The present investigation could not determine the
magnitude of influence of the heat load on the truck due to solar radiation during
loading.

During transport, the pigs calm down and the heat stress is reduced due to a lowered air
temperature as a result of increased ventilation. By directing the incoming air using roof
openings, the pigs in the upper deck could get an acceptable thermal environment even
at outside temperatures up to 28°C. However, this arrangement meant that the pigs in
the forward end on the lower deck had a poorer thermal environment due to the internal
air movements inside the truck. Installation of air guiders in the ventilation openings
along the outside truck walls increased the air movement among the pigs and hence
reduced heat stress at high outside temperatures.

The evaluation of pig stress level after slaughter by the cortisol levels after transport
could not show any difference between the different transport trips, however there were
large differences between individual pigs in the same transport. It was concluded that a
better methodology is needed to obtain a correct assessment of pig stress level, and this
is not available at present. The behaviour studies carried out to assess aggression, thermal and other indicators of stress all have weaknesses, because the video recordings inside the truck could not document all pigs in the observation pen at the same time. However, the technology to obtain these types of recordings is available today.

The present project has indicated the missing information and competence to improve animal welfare during transport and handling, and hence the following problem areas ought to be studied and evaluated in the future:

- Influence of the size of ventilation openings along the side walls and roof openings of the truck on the air flow and temperature development inside a truck when standing still;
- Effect of a mechanical air distribution system providing fresh air and air movement to all pens in the upper and lower decks when a truck is standing still;
- Effect of water sprinkling on the pigs when the truck is both standing still and under transport should be tested and an evaluation made whether forced air movement is required to achieve the desired effect;
- Determination of the location and design of air guiders in the truck ventilation openings providing the best air movement around the pigs during transport, thus improving the cooling effect during warm days;
- Influence of air guiders in the ventilation openings on the air exchange rate in the truck during transport;
- Influence of opening in the rear of the truck on air flow and air movement inside;
- Designing adjustable ventilation openings;
- Influence of grouping pigs to the same number as they will be in the transport pen some days prior to the loading;
- Development of improved methodology to study the behaviour, welfare and stress level of the animals during transport;
- Investigate and determine the optimum acceptable threshold vibration values for pigs under different conditions of transport.

Future transport studies ought to be conducted in such a way that test and control situation can be performed simultaneously i.e. in same outside climate.

If improved statistics about the number pigs dying during transport were available, the causes could better be clarified and measures brought into use. The meat industry and the Board of Agriculture should therefore as soon as possible introduce a reporting system for animals dying during or as a result of transport.