JRC Scientific and Technical Reports

STUDY ON TEMPERATURES DURING ANIMAL TRANSPORT

FINAL REPORT

IN THE FRAMEWORK OF THE
ADMINISTRATIVE ARRANGEMENT
BETWEEN DG SANCO AND JRC
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EXECUTIVE SUMMARY

The study compares the temperature standards in force and the standards proposed by scientists with the actual practices of commercial transport in the EU, providing a realistic picture about the temperatures experienced in animal transports along the most important trade flows and climatic conditions in Europe.

Over a 9 months period from February to October 2009 temperature and humidity records from 21 vehicles and 515 journeys were analysed.

With temperature/humidity sensors at 4 different positions in the vehicles, differences were recorded between the highest and lowest temperature at any given moment which exceeded in nearly 7% 10° C. The position of the worst climatic conditions may change within an animal compartment due to a number of factors. The number and position of temperature sensors are important for representing the most temperature conditions in the different parts of a vehicle.

The data show that up to ~ 20°C external temperature, the presence of animals in a transport vehicle could be detected by the difference between the sensor in the front down part of the vehicle and the external sensor with highest differences for pigs up to 30 kg and sheep above 6 months. Above ~ 20°C the presence of animals seems not to add significantly to the temperature measured by the external sensor.

Overall for all journeys and all animal categories a relatively high percentage of non-compliant journeys can be observed (see table below). The temperature thresholds proposed by EFSA would result in general in a higher percentage of non-compliant conditions, more prominent for the lower threshold for which the non-compliant journey times would almost double compared to the thresholds laid down in Regulation (EC) 1/2005. When excluding non-compliant temperatures which occur for less than 2 consecutive hours, the non-compliant journeys against EFSA thresholds would decrease from 52% to 27 % for the upper limits and from 44% to 31% for the lower limits.

		% of journeys with at least one case of non-compliance	% of journey time during which he threshold was exceeded
Upper threshold	**30º C**	**48%**	**10%**
	EFSA	**52%**	**13%**
	EFSA ≥ 2h	**27%**	
Lower threshold	**5º C**	**26%**	**6% - 10% (*)**
	EFSA	**44%**	**14% - 20% (*)**
	EFSA ≥ 2h	**31%**	

(*) upper value includes simulated results for November – January on the bases of climatic conditions during 2007/2008

With respect to the different animal categories, the non-compliant temperature occurrences where more frequent in pigs and sheep, in particular with regard to the EFSA proposed thresholds. Despite the large number of journeys recorded, the numbers for each category of animals are too small to evaluate the impact of the thresholds proposed by EFSA for the trade along the main flows of all animal categories.

General temperature data for Europe show that conditions with minimum temperatures below 5° C are around 5 times more frequent than above 30° C. However, the main flows of animals are related to geographical areas which are characterized by moderate or warmer climate. Taking into account predicted climate changes in Europe towards milder winters and more extreme conditions in summer it could be likely that non-compliant journeys for the lower limits decrease whereas non-compliant journeys for the upper limits increase.

1. INTRODUCTION

Temperature standards apply in the EU to long journey transports of horses, cattle, pigs, sheep and goats since 1998 (Council Regulation (EC) No 411/98). Actually, a temperature range from 5°C to 30°C with a ± 5°C tolerance is applicable as laid down in Council Regulation (EC) No 1/2005[1] which replaced Regulation (EC) No 411/98.

Two scientific opinions on temperature standards for the transport of animals, adopted in 1999[2] and 2004[3], proposed different temperature ranges in respect of different categories of animals. In 2006, the Commission submitted a draft regulation on temperature standards at the Standing Committee on the Food Chain and Animal Health as to reflect the latest scientific opinion. However, most Member States did not support the proposed figures. Most delegations were uncertain on the consequences of the new standards and they suggested postponing the adoption of new temperature standards until more information on the possible impacts is available.

Since the adoption of the above scientific opinions further studies were carried, mainly designed for mastering ventilation to ensure acceptable temperature ranges, measuring stress parameters in animals during transport, or understanding the vectors which influence the body temperature during transport (for a brief overview see Annex I). Very little data was available regarding the temperatures livestock is normally exposed to during commercial long journey transports throughout Europe. JRC was requested to carry out the study “Temperatures during Animal Transport” aimed to provide a comprehensive picture on the temperatures livestock is normally exposed in commercial transports along some main trade streams in Europe.

Scope of the document

In this document JRC provides a report of the above mentioned study, describing the methods, installation of devices and the results from the data recorded from February until October 2008.

2. PROCEDURAL ISSUES

The study is carried out under the administrative arrangement with DG SANCO, along the terms of reference set up by DG SANCO. The temperature data were recorded in commercial animal transports with the cooperation of voluntary participating transport companies.

The content of this report may not necessarily reflect the views of the European Commission and does not prejudge the final form of any decision to be taken by the European Commission.

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[1]) Council Regulation (EC) No 1/2005 of 22 December 2004 on the protection of animals during transport and related operations and amending Directives 64/432/EEC and 93/119/EC and Regulation (EC) No 1255/97 – OJ L3, 05.01.2005, p.1

[2]) Standards for the Microclimate inside Animal Transport Road Vehicles, Report of the Scientific Committee on Animal Health and Animal Welfare, Adopted 8 December 1999

[3]) *The EFSA Journal* (2004), 122, 1-25, Standards for the microclimate inside animal road transport vehicles

3. OBJECTIVES OF THE TEMPERATURE STUDY

The purpose of this study is to compare the temperature standards in force and the standards proposed by scientists with the actual practices of commercial transport in the EU and to identify the possible gap and negative consequences of the existing practices and trade flows. The study should reflect the variety of the climatic conditions experienced in the different parts of the EU taking into account the possible long term evolution of climate changes.

4. PREPARATION OF THE STUDY

The project plan, describing the planning, preparation and execution of the study, was presented to DG SANCO in November 2007. The relevant details of the project plan are shown in Annex I-III.

4.1 ANIMAL FLOW AND SELECTION OF JOURNEY TYPES/ROUTES

Temperature data were collected for pigs, cattle, sheep, goats and horses and compared with the temperature ranges in force and the ranges recommended by EFSA (see Annex II.1).

Data from TRACES for 2005 and 2006 about livestock transports within, into and from the EU were analysed to identify the main flow patterns in respect of number of animals transported and number of transports.

On the basis of the data from TRACES and from the Food and Veterinary Office of DG SANCO, some major flows for the above listed livestock as shown in the table below were identified. These flows fulfill the following criteria

- o journeys of more than 8 hours between at least two countries,
- o a substantial flow of animals/transports,
- o regional temperature differences between Member States of origin and destination or along the journey.

Category of animals	Transports from	to	% of transports*) % of animals *)	
pigs	Denmark, Netherlands	Italy, Spain, Poland	12% 18%	of pigs in intra Community trade (ICT)
cattle	Poland	Italy, Spain	43% 38%	of cattle in ICT
	France, Germany	Poland (= export Russia)		exports
sheep	Hungary	Italy, Spain, Greece	31% 36%	of sheep in ICT
	Romania	Italy , Spain	6% 7%	of sheep imported
horses	Poland	Italy	25% 43%	of horses in ICT
	Romania, Bulgaria	Italy	20% 63%	of horses imported

*) in TRACES species were not further differentiated by age or weight categories

Table 1: Some of the major long journey flows for livestock by countries of origin and countries of destination (percentages regarding the number of transports and animals are based on TRACES figures for 2006)

4.2 PARTICIPATING TRANSPORT COMPANIES AND VEHICLES

It was tried to get participation of transport companies carrying out amongst others commercial animal transports along the above mentioned main flows. 10 transport companies from 5 Member States (Denmark, Germany, Italy, the Netherland and Poland) volunteered in the study.

For transports of sheep from Hungary to Greece no company was found to participate in the study.

One transport company in France, although willing to participate in the study, could not agree on the location where to install the temperature sensors and did therefore not participate. Also transport associations and companies in Spain and the United Kingdom were invited to participate in the study.

During installation of the temperature recording system the details of the participating vehicles regarding type, equipment and animals normally transported were recorded as listed below.

Type of truck: semi-trailer, truck, truck and trailer, number or tiers;

Equipment on truck: natural / mechanical ventilation, water supply, misting devices, rugs, insulation, roof colour.

As shown in the table below, 21 commercially used vehicles, consisting of a truck & trailer or of a semi-trailer, participated in the study. The fleet of participating vehicles presented 7 major brands of vehicle manufacturers in Europe, including older and new vehicles (built between 1993 and 2007), most with insulated roof, none with a misting system. Although some of the vehicles are used exclusively for one species (e.g. horses or pigs only), others are used for more than one species.

Number of vehicles	Mainly used for	Types of vehicle equipped with recording system
8	Pigs	5 trucks + 2 trailers, 3 semi-trailers
7	Cattle	3 trucks, 4 semi-trailer
2	Sheep, goats	2 semi-trailers
2	Pigs, cattle, sheep	2 semi-trailers
2	Horses	1 truck, 1 semi-trailer
21		**9 trucks +2 trailers, 12 semi-trailers**

Table 2: Number of vehicles fitted with temperature sensors

All 9 trucks and 12 semi-trailers were equipped with the recording devices described in section 4.3. In 2 trucks transporting pigs, in addition also the trailers got recording devices installed.

Within the reported period of the study, 3 of the originally participating vehicles were substituted by other vehicles. For details see Annex III.

4.3 METHOD OF DATA COLLECTION AND RECORDING

Most participating vehicles were already equipped with some temperature recording systems. However, the number and location of the sensors showed a wide variety. Despite existing temperature recording systems, for the study data loggers with integrated temperature/humidity sensors were installed in each participating truck or semi-trailer to ensure comparable results between the vehicles.

For the study 4 such recording devices were installed inside each participating vehicle (1 in the upper front part, 1 in the lower front part, 1 in the upper back part and 1 in the lower back part of the animal compartment) and 1 on the outside of the vehicle.

The data loggers were set to record over the entire data collection period the measured temperatures and humidity in 15 minutes intervals.

From the initially 113 devices installed, 10 were replaced during the study, 4 of them due to recording failure.

At installation of the recording devices, JRC provided each transport company participating in the study with a project description including instructions what additional data are requested for each journey and how the additional information should be provided. The drivers were asked to record for each long journey additional information regarding management of welfare parameters (e.g. use of bedding, mechanical ventilation). The English version of the project description and the information requested in addition to the journey log is shown in Annex III.

The specifications of the sensors, data loggers and the installation scheme are displayed in Annex III. The installation of the devices, download of records and collection of additional data from the journey logs were done by JRC staff.

5. DATA COLLECTED

Data have been downloaded from 123 data loggers installed on the participating vehicles, providing a total of 2,336,946 records of temperature and humidity. Each record is representing the temperature and humidity registered at 15 minutes intervals by the 4 sensors placed inside the vehicle and by 1 external sensor placed outside of the vehicle.

For identifying the individual journeys for which the temperatures/humidity are monitored, the category and number of animals loaded, start, rests and end of the journeys were extracted by JRC staff from the completed journey log of each animal journey. These data were collected while visiting the companies for downloading the records from the data loggers.

The recordings cover the periods indicated for each vehicle in Annex IV.

Of the data downloaded, 278,450 records are related to 515 animal journeys. The records of temperature and humidity were linked to animal journeys on the basis of the declarations of start and of end of the journeys provided by the transport companies.

The following table shows the distribution of journeys and of the number of transported animals by category of animals and by month. A more detailed overview of the journeys with origin and destination is given in Annex IV.

Cat. of animals	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	**Total**	Nr animals
Pigs <= 30 kg	20	12	22	28	13	28	22	18	3	**166**	117551
Pigs > 30 kg	22	18	4	15	18	15	10	7		**109**	19517
Bovines < 6 Mo	2	8	9	10	5	4	5	5	1	**49**	7147
Bovines > 6 Mo	11	7	18	10	9	13	8	9	2	**87**	3098
Sheep < 6 Mo	3	9	4	4		3	3	2		**28**	19313
Sheep > 6 Mo			3		1	4	2	1		**11**	5895
Goats	2		1							**3**	2230
Horses	6	4	6	9	7	9	6	7	7	**61**	1029
Other	1									**1**	31
Total	**67**	**58**	**67**	**76**	**53**	**76**	**56**	**49**	**13**	**515**	**175811**

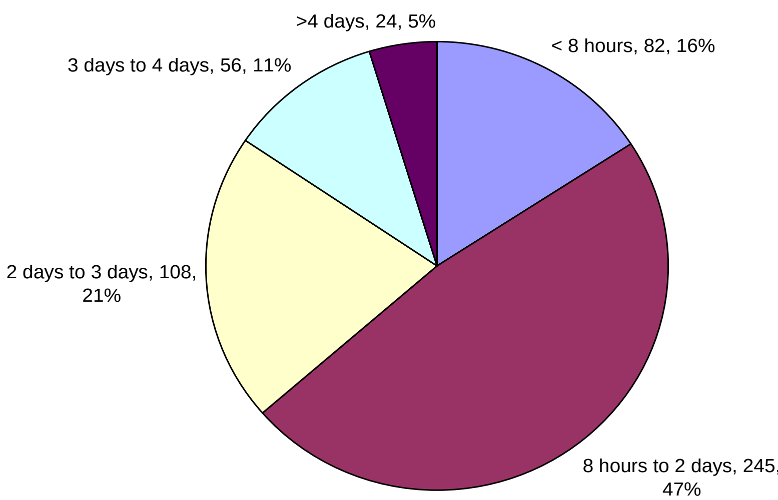
Table 3: Journeys recorded for the 21 participating vehicles

Out of the 515 journeys

- 45% of the recorded pig transports covered the main flows from Denmark and the Netherlands to Germany, Italy, Spain and Poland;
- 55% of the recorded cattle transports followed the flows from France, Germany and Poland to Italy, Spain and to eastern countries;
- 81% of the recorded sheep transports were along the routes from Hungary, Romania to Italy and Spain, or from Spain to Italy;
- 72% of the recorded horse transports covered the main routes from Poland, Romania and Bulgaria to Italy.

17 out of the 515 journeys included a ferry transport, e.g. transports to Greece or from the United Kingdom to continental Europe.

More than 2/3 of the recorded 515 journeys lasted between 8 hours and 3 days, around 16% for 4 days or more.



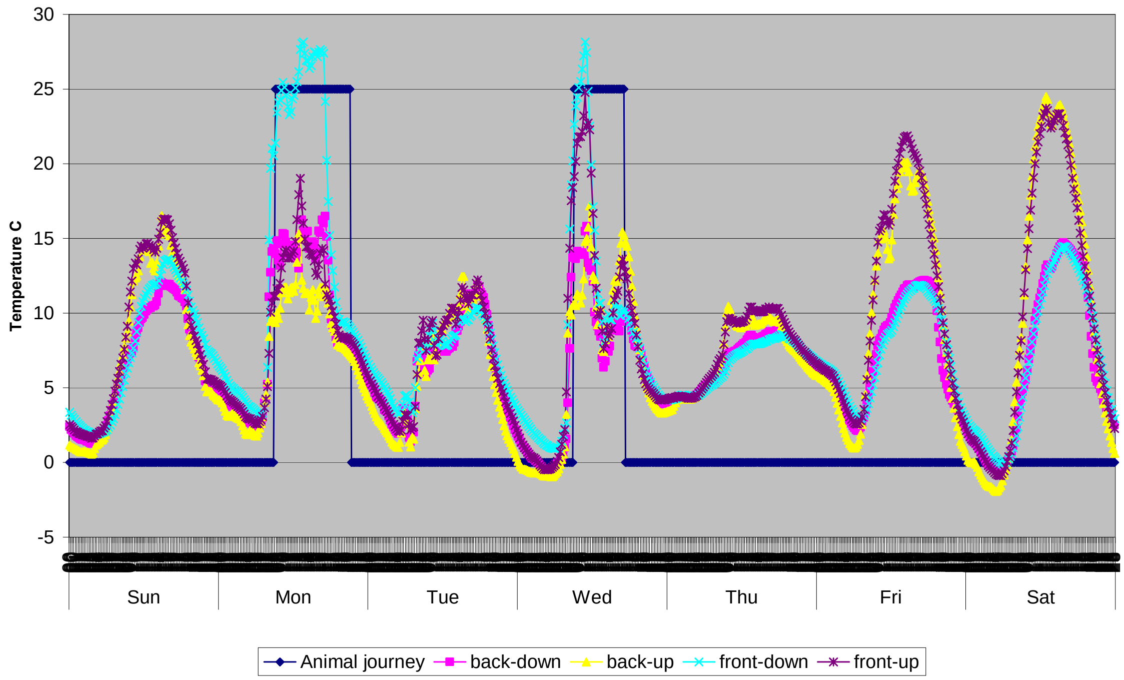
Picture 1: Duration of the recorded animal journeys

6. RESULTS

6.1 BEHAVIOR OF TEMPERATURES AND HUMIDITY

The variations of the temperature recorded by the different sensors on each vehicle over time were determined not only by daily and seasonal cycles but also by different climate conditions encountered during the movements of the vehicles, by the presence of the animals, by the circulation of air induced by the movement of the vehicle and by possible interventions on animal welfare, like mechanical ventilation.

The following picture shows an example of variations of temperatures for the different sensors on a specific vehicle during one week period. The squared line indicates the periods of two declared animal journeys.

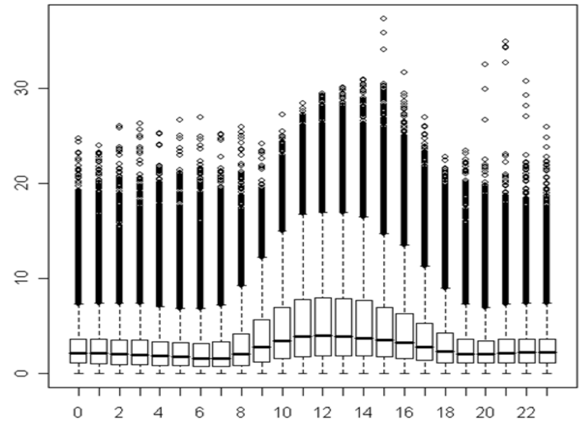


Picture 2: Example of temperatures variations over a typical week

From the example at least two patterns emerge: the increase of temperatures in the front down part of the vehicle during the animal journeys and the increase of temperatures recorded by the sensors in the upper tier during the central hours of the day. This increase is more evident on Fridays, Saturdays and Sundays when the vehicle was not moving.

In general, from the example above there are at times strong differences of the internal temperatures depending of the position of the sensors. Analysing the entire set of recordings, on average the differences between the maximum and minimum temperatures recorded inside the vehicles were of 3.5°C and in 6.7% of cases differences were above 10°C.

These differences tend to increase in the central hours of the day. The following picture indicates the distributions of the differences between maximum and minimum temperature by hour of the day. At 12:00 am the differences have a median around 4°C and 50% of the values are distributed between 2°C and 8°C.



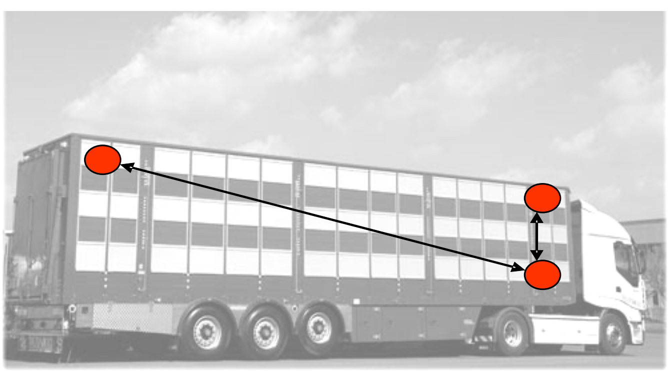
Picture 3: Box-plot of the differences between maximum and minimum temperatures recorded on each vehicle by time of the day

Looking at the correlations among the records of temperatures in the different positions of each vehicle, temperatures in the front and back of the same tier have a similar behavior (stronger correlation), whereas the differences tend to emerge between front up and front down or back up and back down parts of the vehicle (weaker correlation).

	back-down	back-up	front-down	front-up
back-down	1.00	0.92	0.96	0.92
back-up	0.92	1.00	0.87	0.98
front-down	0.96	0.87	1.00	0.89
front-up	0.92	0.98	0.89	1.00

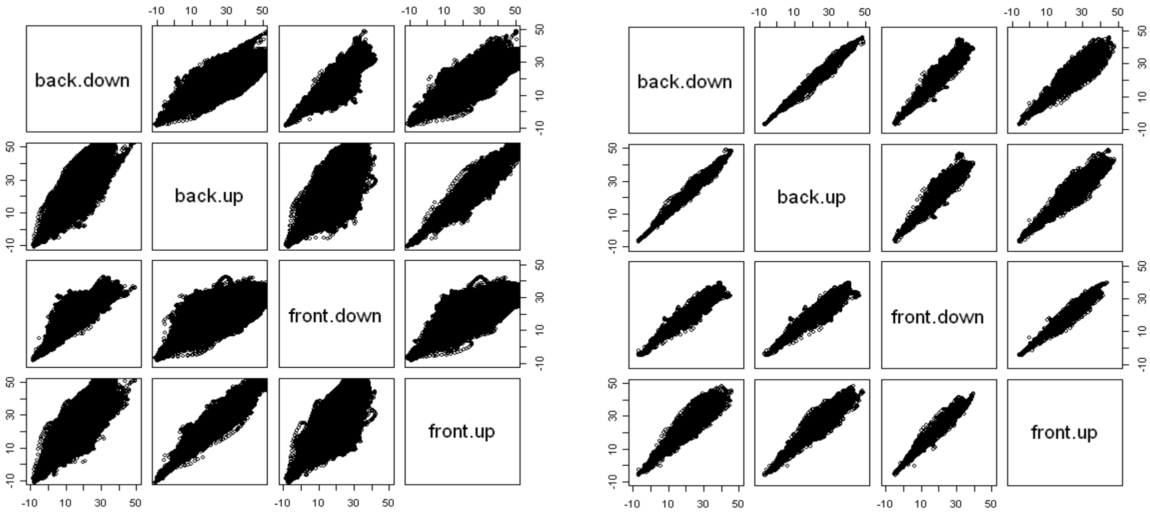
Table 4: Correlation coefficients between temperatures recorded at different positions in multi-tier semi-trailers

The following pictures shows the combinations of positions where the weakest correlations were recorded. Between these positions it could be expected to have the highest variability of conditions.



Picture 4: Position of sensors in a semi-trailer with the lowest correlation

Correlations tend to be stronger in mono-volume vehicles, like those used for transporting horses, rather than in multi-tier vehicles.

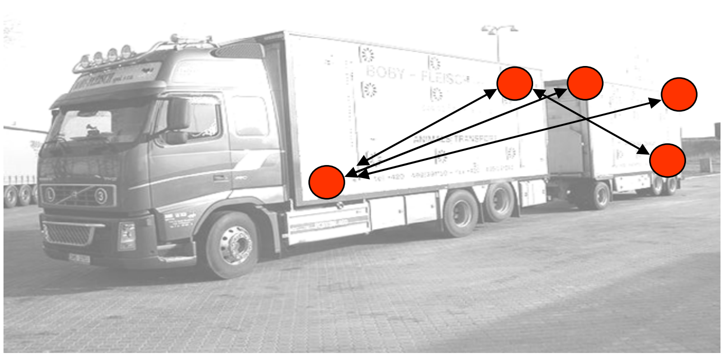


Picture 5: Pairs plots of temperatures recorded in the different positions; the compact diagonal line indicate stronger correlation between the pairs, e.g. front-up with back-up and front-down with back-down. The plots on the left are relative to multi-tiers vehicles while the plots on the right are relative to single tier vehicles

In vehicle composed by a truck and a trailer the correlations are lowest between the extreme diagonal positions as shown by the following table and picture.

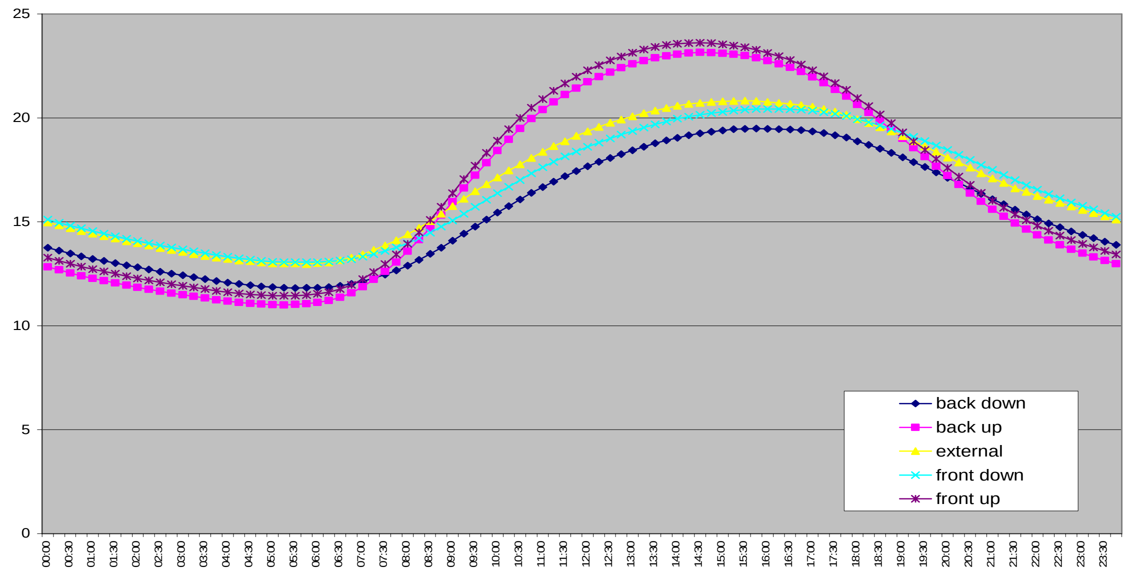
	back-down-trailer	back-down-truck	back-up-trailer	back-up-truck	front-down-trailer	front-down-truck	front-up-trailer	front-up-truck
back-down-trailer	1.00	0.90	0.91	0.84	0.98	0.91	0.92	0.88
back-down-truck	0.90	1.00	0.89	0.93	0.92	0.92	0.90	0.95
back-up-trailer	0.91	0.89	1.00	0.94	0.93	0.82	0.99	0.93
back-up-truck	0.84	0.93	0.94	1.00	0.87	0.83	0.94	0.98
front-down-trailer	0.98	0.92	0.93	0.87	1.00	0.90	0.95	0.90
front-down-truck	0.91	0.92	0.82	0.83	0.90	1.00	0.84	0.90
front-up-trailer	0.92	0.90	0.99	0.94	0.95	0.84	1.00	0.94
front-up-truck	0.88	0.95	0.93	0.98	0.90	0.90	0.94	1.00

Table 5: Correlation between sensors on a truck and trailer



Picture 6: Position of sensors with the lowest correlation in a truck and trailer

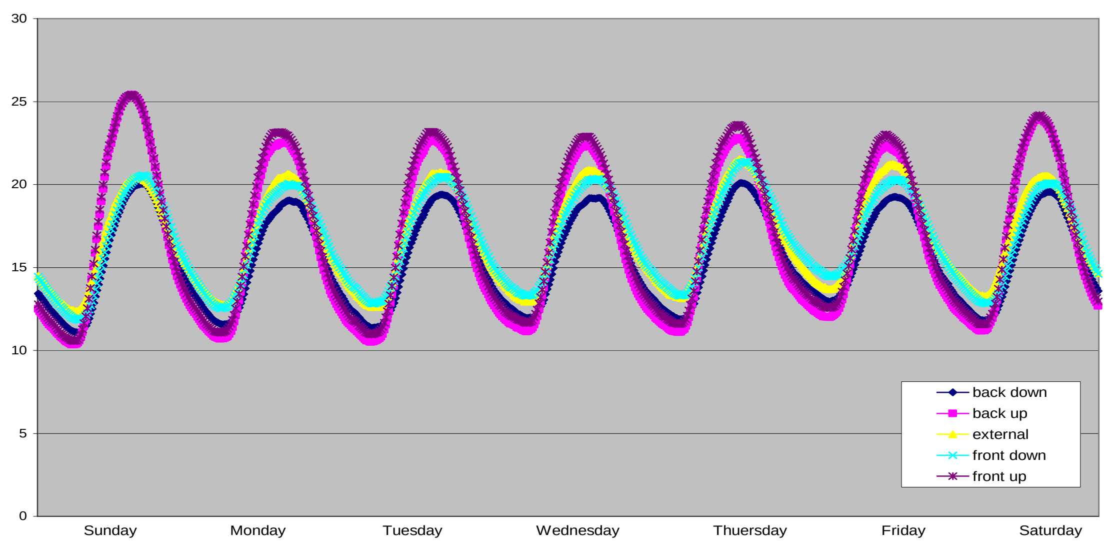
The evolution of the average of temperatures by time shows a clear and typical pattern of sinusoidal variation.



Picture 7: Typical daily temperature pattern recorded from all five temperature sensors on a vehicle

The internal temperatures follow in principle the same behavior of the temperature on the external sensor with a time shift and an amplified effect for the upper tier. Despite the insulated roof in most of the vehicles, in the central hours of the day the temperature in the upper tier becomes higher than in the lower tier and in the exterior. This effect is reversed during the night when the temperature in the lower tier becomes equal or slightly higher than the temperature of the upper tier.

In general, the temperatures in the lower tier tend to be lower than the temperatures at the exterior. The difference of temperatures between the upper tier and the lower tier are more evident on Sundays and Saturdays when a vehicle is more likely not moving, while, during the week and during animal journeys, the movement of the vehicle mitigates the effects of solar radiation.

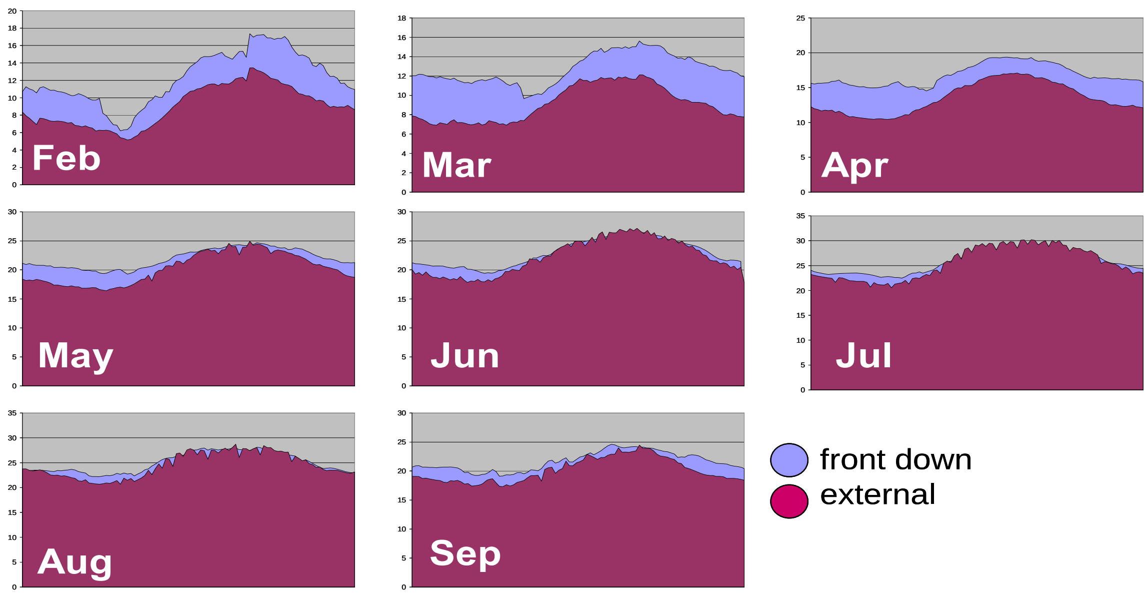


Picture 8: Weekly variations of temperatures recorded by the different sensors

During the movement of the vehicle temperatures in the back of the upper tier are lower than the temperature in the front.

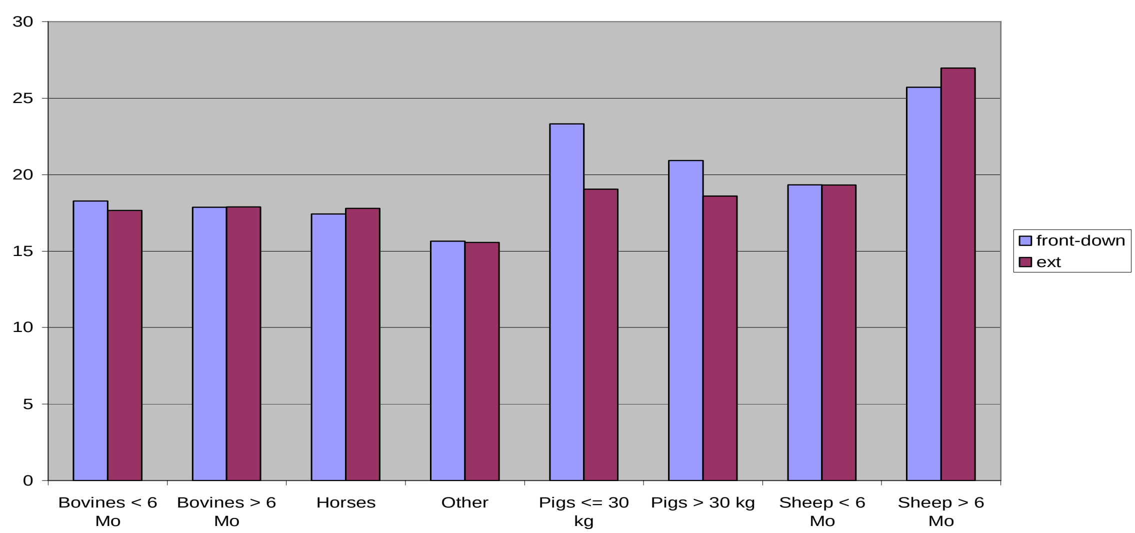
The sinusoidal pattern is not present during periods of transport on ferries.

During animal journeys the presence of animals causes an increase of the temperatures in particular in the less aerated front down part of the vehicle. This effect is evident during the winter season and at night time. On the contrary, in summer and more in general, with temperatures above 20°C the presence of the animals is not causing an additional increase of temperatures in respect of the exterior.



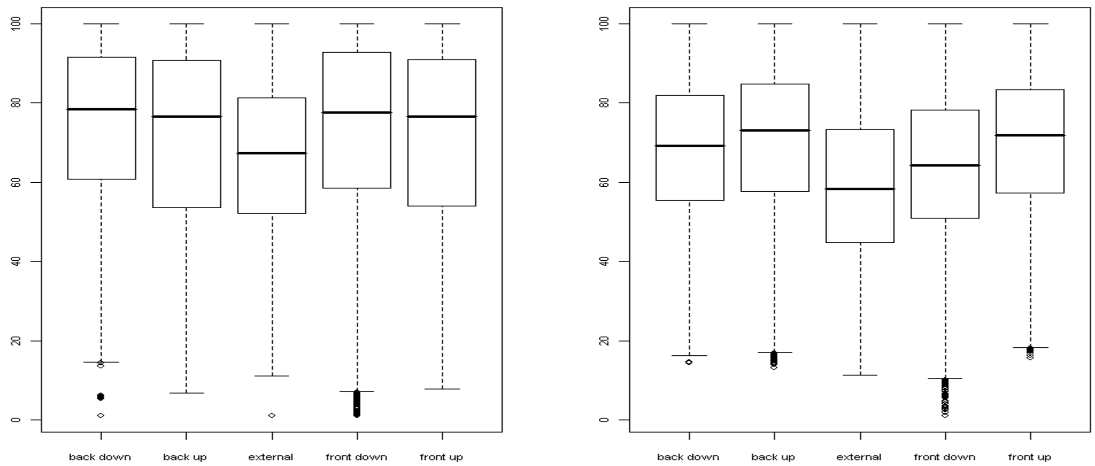
Picture 9: Average of temperatures recorded by the front-down sensor compared to the temperature recorded by the external sensor during animal journeys by month and time of the day (all animal categories)

Among the different categories of animals, pigs up to 30 kg are more contributing to the increase of temperatures observed in the front-down part of the vehicle.



Picture 10: Average of temperatures recorded by the front-down sensors compared to the temperature at the external sensor during animal journeys by category of animals

Humidity values were mostly distributed in the range between 60% and 90%. Except for the external sensor, there were no high differences of the humidity values recorded in the different parts of the vehicle. During animal journeys the humidity decreased on all sensors to values below 80% as is shown below.



Picture 11: Box plot of relative humidity recorded by the sensors in the different positions; left plot for the whole period, right plot with values recorded during animal journeys

The following table shows the correlations between humidity and temperature for the different positions of the sensors. In general there is a negative correlation between temperature and humidity. The negative correlation is stronger in the sensor in the upper tier where also the major temperature fluctuations are recorded.

Sensor position	Correlation coefficient
front-up	-0.69
front-down	-0.43
back-up	-0.69
back-down	-0.54
external	-0.61

Table 6: Correlation coefficients between temperatures and humidity recorded at different positions

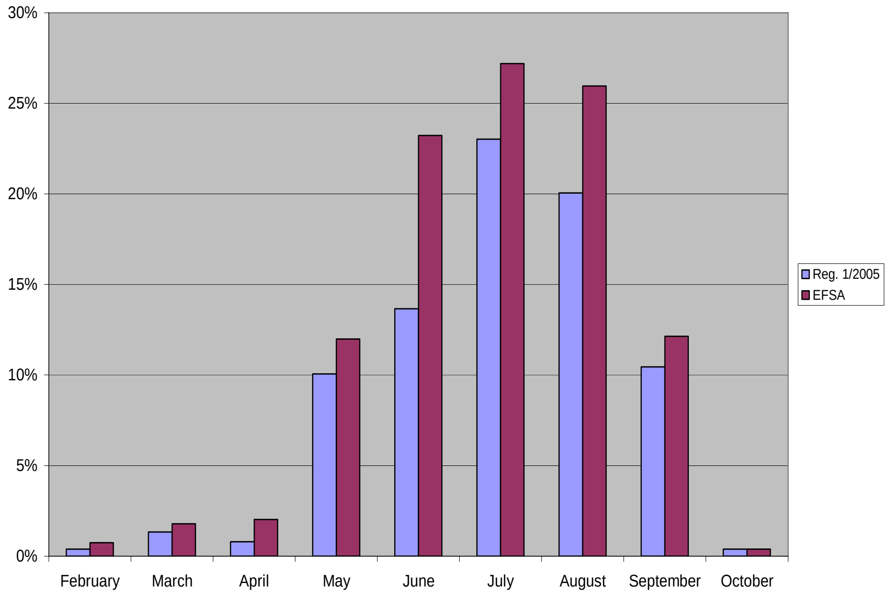
6.2 IMPACT OF HIGH TEMPERATURES THRESHOLDS

When comparing the temperature data during animal journeys with the acceptable temperature range in force and with the thresholds proposed by EFSA the following observations were made (for the temperature thresholds see Annex I).

During the 515 journeys of all animal categories the maximum temperatures inside the vehicle exceeded in 10% of the journey times the limit of 30ºC and in 13% the limits proposed by EFSA. These percentages were calculated as the sum of records when the temperature by at least one of the internal sensors was above the threshold, divided by the duration of the journeys (53,065 intervals of 15 min).

In 48% of the journeys of all animal categories there was at least one non-compliant occurrence against the 30ºC limit (temperature record above 30ºC) and on average each journey had 11 non-compliant occurrences. In the case of the

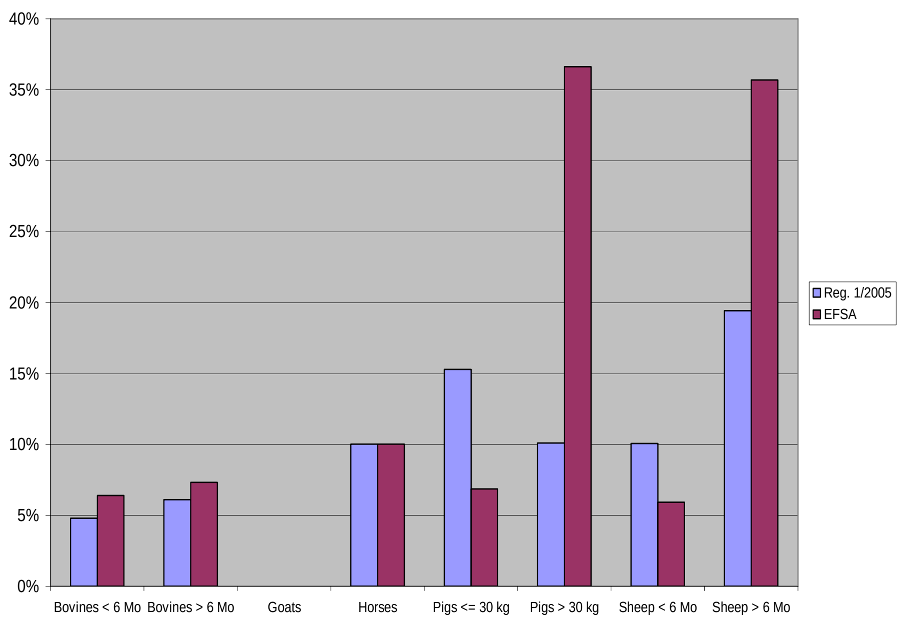
EFSA limit, in 52% of journeys there was at least one non-compliant occurrence and on average each journey had 14 non-compliant occurrences.



Picture 12: Percentage of the journey times the temperature inside the vehicle exceeded the limit of 30ºC and the limits proposed by EFSA during animal journeys by month (all animal categories)

As shown in the picture above, related to all animal categories together, most non-compliant occurrences were recorded between May and September. In the month of July their level reached 23% for the 30º C limit and 27% for the EFSA limits.

The following picture represents the number of non-compliant occurrences by category of animals.

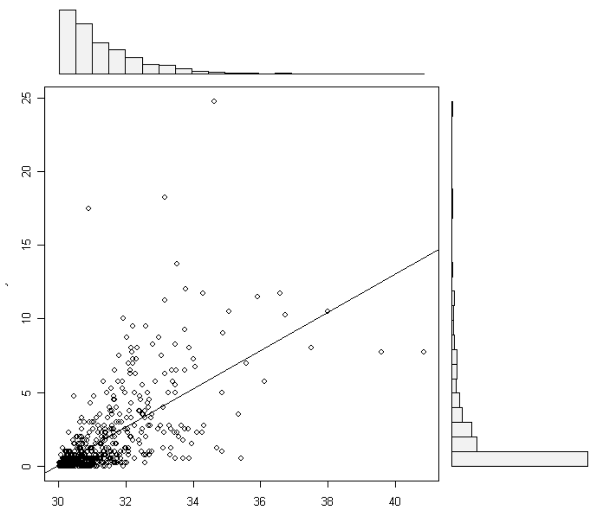


Picture 13: Percentage of the journey times the temperature records inside vehicles exceeded the limit of 30ºC and the limits proposed by EFSA during animal journeys by category of transported animals

In pigs over 30 kg and sheep older than 6 months the EFSA limits produced the largest increase in non-compliant occurrences compared to the 30ºC limit. On the contrary, EFSA limits resulted less severe in pigs up to 30 kg and sheep <6 months.

Besides the absolute number of non-compliant occurrences during animal journeys, also their consecutive durations versus their average value were analyzed.

The following picture shows together for all animal categories the average temperature during consecutive periods with maximum temperatures on at least one of the internal sensors exceeding the limit of 30ºC versus the duration of each of these periods. Bar-charts along the axis represent the frequency distributions of temperatures and durations in hours. The durations of consecutive periods with non compliant temperatures were mostly under one hour.



Picture 14: Average temperatures for consecutive periods with temperatures above 30ºC (x-axis) versus duration in hours of these periods (y-axis)

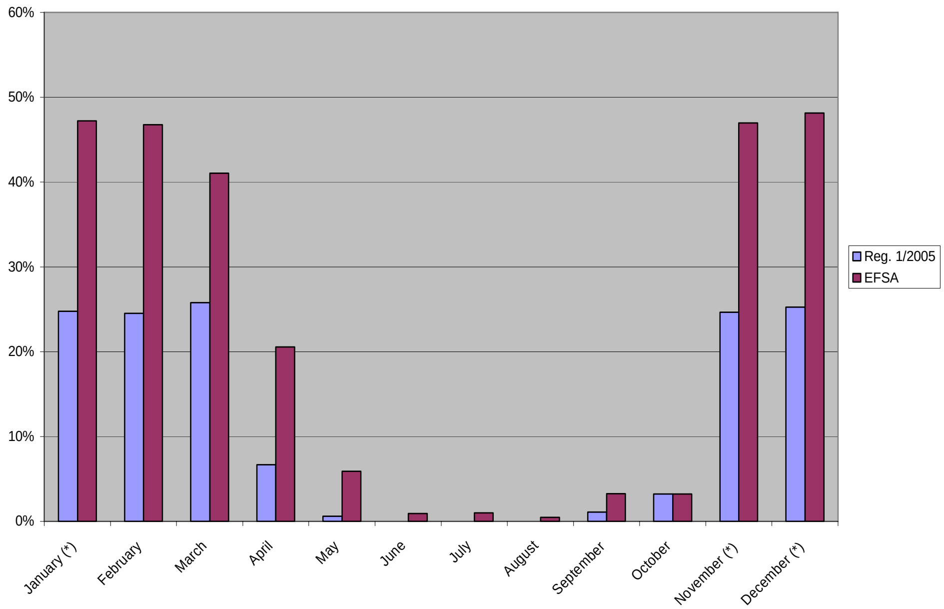
Out of all 581 recorded consecutive non-compliant occurrences of 15 minutes or longer above 30ºC, 75% had durations of less than 2.5 hours and average temperature of less than 32ºC. In 78 cases (13%) they exceeded 5 hours.

6.3 IMPACT OF LOW TEMPERATURES THRESHOLDS

During the 515 journeys of all animal categories the minimum temperatures inside the vehicles have been below the limit of 5ºC in 6% of the journey times and in 14% below the limits proposed by EFSA (calculated as the sum of records when the temperature by at least one of the internal sensors was below the threshold, divided by the duration of the journeys - 53,065 intervals of 15 min).

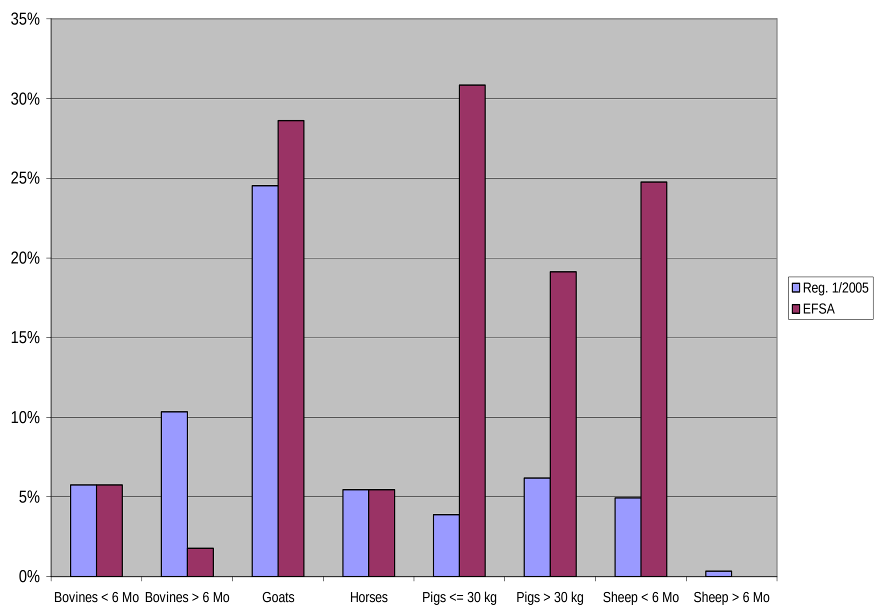
In order to get figures representative for the whole year the level of non-compliant occurrences for the missing months of November, December, and January was simulated on the basis of past climatic conditions in 2007/2008. With this simulation the non-compliant journey times would reach 10% in the case of the 5ºC limit and 20% in the case of the EFSA limits.

Most non-compliant occurrences for low temperatures appear between February and March. In the month of February in 25% of the journey times at least one temperature record was below the 5ºC limit and in 45% below the EFSA limits.



Picture 15: Percentage of the journey times with temperatures inside the vehicles below the limit of 5ºC and the limits proposed by EFSA during animal journeys by month (all animal categories)
***) levels of non-compliance simulated on the basis of climatic conditions in 2007/2008**

In 26% of the journeys of all animal categories there was at least one case of non-compliant occurrence against the 5ºC limit and in 44% against the EFSA limits with an average of 7 and 15 cases of non-compliant occurrences per journey, respectively.



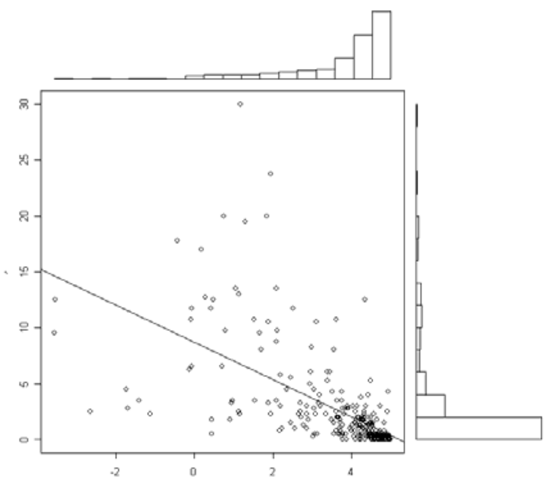
Picture 16: Percentage of journey times with temperatures inside vehicles below the limit 5º C and the limits proposed by EFSA during animal journeys by category of transported animals

The EFSA limits for low temperatures resulted more severe than the 5ºC limit in particular in pigs, sheep up to 6 months and in goats. In the case of pigs up to 30 kg there was a 6-fold increase of non-compliant occurrences during journeys in respect to the 5ºC limit.

In contrary, for bovines over 6 months of age the EFSA limit would result in a reduction of non-compliant occurrences during journeys to around 1/5 of the value recorded against the 5ºC limit.

Similarly to the high temperatures, the following picture shows for all animal categories together the average temperature during consecutive periods with temperatures on at least one of the internal sensors below 5ºC versus the duration of each of these periods. The durations of consecutive periods with non-compliant temperatures were mostly less than 2 hours.

Out of 318 recorded cases of non-compliant temperatures below 5ºC, 75% had durations of less than 2.7 hours and average temperatures of more than 4.7ºC. In 46 cases (14%) the consecutive duration of non-compliant occurrences exceeded 5 hours.



Picture 17: Average temperatures for consecutive periods with temperatures below 5ºC (x-axis) versus duration in hours of these periods (y-axis)

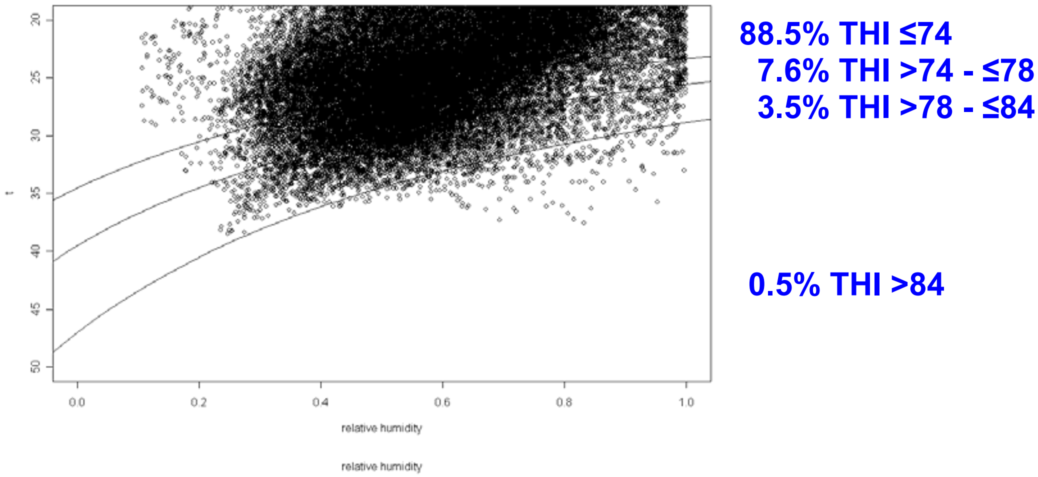
6.4 IMPACT OF TEMPERATURE AND HUMIDITY

In order to consider the possible combined effect of temperature and humidity for each recording the temperature humidity index (THI) according to the following formula was calculated:

$$THI = 0.8\ \mathrm{T} + RH\ (T\text{-}14.4) + 46.4$$

where: T = temperature recorded by the sensor (°C) and RH = relative humidity (%).

The following picture shows the THI values from the temperatures and humidity records during the recorded journeys of all animal categories. For reference, the THI values 74, 78 and 84 are outlined as thresholds used by the “Livestock Weather Safety Index” (LWSI).

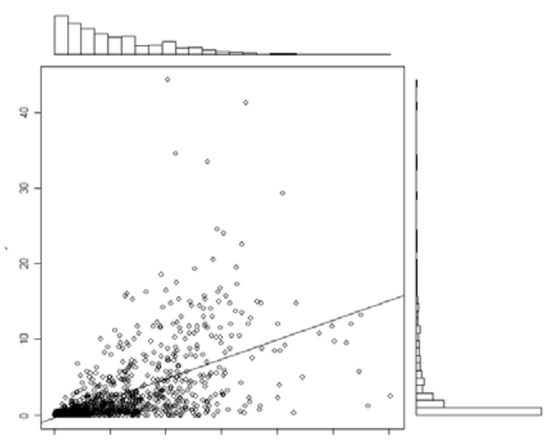


Picture 18: Calculated THI values from the records of temperatures and relative humidity of all animal journeys of all animal categories; the 3 lines indicate the threshold values of the LWSI; the values given on the right represent the percentage of THI values within the given LWSI limits

The LWSI which was developed and mainly used for the evaluation of productivity decrease in bovine animals[4] indicates the limit of 74 for onset of thermoregulatory mechanisms by the animals, a danger zone between 78 and 84 and an emergency zone with values above 84.

Despite the negative correlation of temperature and relative humidity (see Table 6 in chapter 6.1), several cases of combinations of temperature and humidity which results in high values of the THI have been found.

However, if the durations of consecutive periods of times with a THI value above 74 are taken into account, the durations were mostly limited to few hours as shown in the picture below. Out of all 1078 cases in animal journeys in which temperature and relative humidity resulted in a THI value above 74, in 78 cases (7%) the elevated THI was present for more than 10 hours.



Picture 19: Average values of THI above 74 for consecutive periods - THI values versus duration in hours of these values

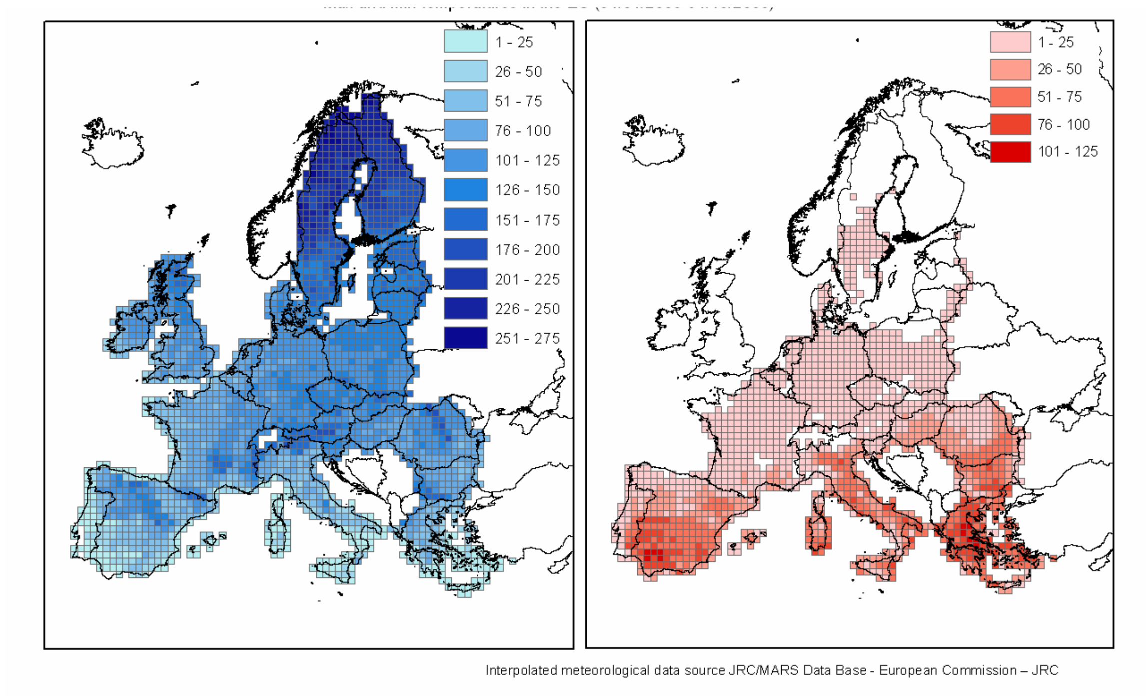
[4]) LCI (1970); Patterns of transit losses; Livestock Conservation, Inc. Esmay, M.L., Dixon, J.E., 1986; environmental control of agricultural buildings; the AVI publishing company, Inc., US. p 285

6.5 IMPACT OF CLIMATIC CONDITIONS

The values of maximum and minimum daily temperatures recorded in Europe in 2008 can give a very broad idea of the climatic condition recorded during the period covered by the study.

The values of temperature were obtained by the JRC/MARS Database of interpolated meteorological data which gives geographical coverage of the entire EU territory with a resolution at 50 by 50 km grids. The following picture shows the geographical distribution of the number of days with maximum temperatures above 30°C and with minimum temperatures below 5°C for the period January – October 2008.

The geographical representation gives an indication of the areas which could be more affected by non-compliances during animal transports.

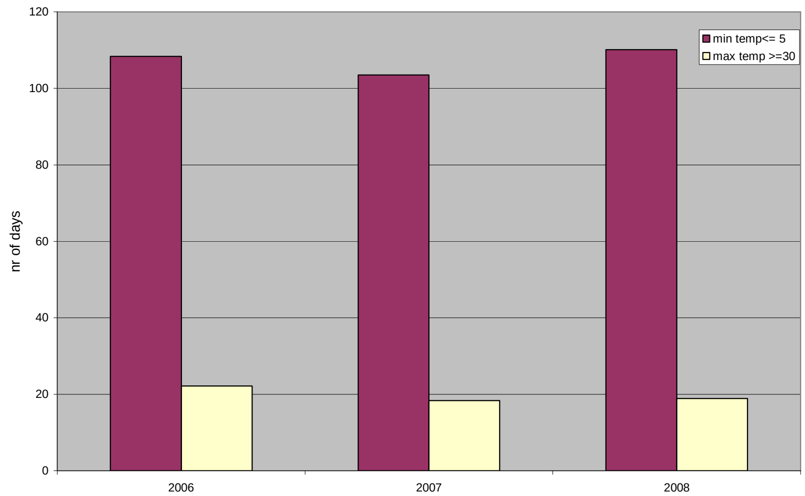


Picture 20: Number of days with temperatures below 5°C (left) and above 30°C (right); period 01/01/2008 – 31/10/2008

The following picture represents the average the number of days above and below the thresholds over the whole territory of the EU for the year 2008, 2007 and 2006.

Despite the exclusion of the month of November and December, conditions with minimum temperatures below 5°C are more frequent in the EU territory than conditions of temperatures above 30°C.

The prevalence of climatic conditions below 5°C is not completely reflected in the level of non-compliances recorded during the study which gives similar values for high and low temperatures. This can be explained by a higher distribution of the recorded animal journeys on geographical areas characterized by warmer climate.



Picture 21: Average number of days with temperatures at or below 5°C and at or above 30°C by year (excluding months of November and December)

In comparison with the previous years, 2008 had fewer days with temperatures above 30°C and more days with temperatures below 5°C, indicating a possible underestimation by the study of the impact of high temperatures in respect of the climatic situation of the past two years.

The assessment of climate change and its impacts is still subject to uncertainties. From available data Europe warmed more than the global average with 0.95°C increase since 1900. Temperatures have increased more in winter than in summer with the strongest warming on the Iberian Peninsula and in northwestern Russia. From some of the climate studies and models for Europe it is concluded that the observed tendency of less cold and frost days and more days above 25°C and more frequent heat weaves will continue[5].

7. DISCUSSION

7.1 RECORDED JOURNEYS ALONG PROPOSED ROUTES

The study with its 515 recorded journeys and more than 175,000 transported animals provide a realistic picture of commercial animal transports along the identified main flows between Member States, into and out of the EU with a good spread over the months. The study will continue to cover a full 12 months period.

However some caution should be considered in interpreting the data in terms of representativeness of all the possible climatic and environmental conditions for the

[5]) EEA report No 2/2004 – Impact of Europe's changing climate; http://reports.eea.europa.eu/climate_report_2_2004/en

trade flows in Europe, since these conditions are influenced by a complex interaction of seasonality, timing and geographical distribution of the journeys.

As regards the number of long journey transports, from the transport activities of previous years more international journeys along the identified routes were expected to take place during the period of the study. The reasons for less transport activities as expected could be summarized as follows:

- Due to animal health measures in connection with Bluetongue disease, in some Member States the trade for ruminants came to a complete halt or was reduced, with effects to the number of transports of cattle, sheep and goats.
- Interruptions of commercial road transports caused by hauliers and/or farmers in different Member States, especially in Italy, France, Spain and Germany related to increased costs for petrol and the low prices for farm products in the beginning of 2008.
- Some of the participating trucks were involved in accidents or had technical problems which caused interruptions in their use.

While temperatures and humidity were continuously recorded on the participating vehicles, the animal journeys and the presence of animals have been obtained from the journey logs. Although sometimes completed accurately, the journey logs presented by some companies did often not reflect the real transport and resting times which could be assumed from visual assessing the temperature behaviour in the vehicles. The information was sometimes entered in a schematic way to conform to driving, transport or resting time requirements or was lacking essential data, e.g. information on starting, resting or arrival time.

In some companies the data from the journey logs could be verified with the data from their fleet management system (navigation and tracking systems).

Additional information on measures taken during an animal journey as regards natural and/or mechanical ventilation was obtained from few drivers only and did therefore not allow drawing conclusions on temperature behaviour in relation to ventilation regimes.

- *Although the study gives a very realistic and profound picture of temperatures occurring in commercial livestock transports in Europe, it can not be considered as representative for all transport conditions which might be experienced along the main routes.*
- *The distinction of temperature thresholds in transport of sheep in respect to the length of the fleece would in practice rather be difficult to apply as this attribute is normally not recorded in accompanying documents and difficult to draw a line between short and long fleece.*
- *Although it was not part of the study to assess the journey logs, the limited reliability and usefulness of the information provided in a large number of journey logs in this study question their usefulness for monitoring animal welfare conditions during transport.*

7.2 TEMPERATURE AND HUMIDITY RECORDINGS

The temperature and humidity recording devices functioned over the period of the study largely satisfactory. 4 out of 113 temperature/humidity sensors showed problems which led to a loss of records. As the problem concerned only sensors in the lower deck of 2 semi-trailers of the same company and was not seen in all the other vehicles, it seems to be caused by the way of washing the vehicles (possible direct jet spray or full immersion of the devices into water over a longer period of time).

- *The set up of the temperature and humidity recording system demonstrated to be reliable also for prolonged use under harsh conditions in animal transports.*

Temperatures and sensor locations

Looking on all records, including phases of animal transport, the sensors in the upper part of the vehicle have an amplified variation between day and night time compared to the external sensor and in the lower part of the animal compartments. The higher temperatures during daytime in the upper part of the vehicles are to a large extent due to the solar radiation, whereas the lower than external temperatures might be due to higher irradiation during night time. This effect is reduced during working days mainly due to the higher ventilation produced by the movement of the vehicles.

The differences observed during the movement of the vehicles between the front sensor and the back sensor in the upper part of the vehicles can be explained, as described also by other studies, with lower pressure behind the vehicle generated by the movement of the vehicle which sucks air from outside into the back of the animal compartments.

The fact, that on average the lower part of the compartments keeps temperatures lower than outside could indicate an effect of insulation of the vehicle against external temperatures.

The high differences in temperature between the 4 internal sensors in the animal compartments which exceeded in nearly 7% of the cases 10°C can be explained with the effects described above.

The recorded data show that in general there is a strong correlation between the 4 sensors in a mono-volume vehicle with only 1 tier as used e.g. for the transport of horses. In multi-tier vehicles a strong correlation is seen between the sensors on the same tier, but much less between sensors in the upper and lower tier. Correlation of temperatures in a truck and the trailer seemed to be weaker than within the truck or trailer.

- *The findings show that it could be problematic to have stops with the animals on board during the central hours of the day unless sufficient mechanical ventilation can be provided.*
- *The findings indicate the importance of the position of temperature sensors. Only with a positioning of sensors based on objective criteria it would be possible to have a good representation of the different temperature conditions*

which are present in the different parts of the vehicle and to compare the data from different vehicles.

- *The results from the temperature records indicate that the location of the worst climatic conditions within the animal compartment change due to a number of factors (e.g. if low or high temperatures are considered, time of the day, external temperature, movement, stops, ventilation). From a practical view under the tested setup, in a mono-tier vehicle one sensor could be sufficient, in multi-tier semi-trailers at least 3 sensors and in truck & trailer configuration 5 sensors should be installed as indicated in pictures 4 and 6 to provide a good representation of temperatures.*

Presence of animals

The increase of the temperatures in the front down part of vehicles linked to the presence of animals could be caused by lower ventilation in that area compared to the back and upper parts.

The effect that the animals were not contributing much to the internal temperature when external temperatures were above 20°C, may be due to the fact that in warm conditions, animals have more problems to transfer heat to their surrounding. The increase of the temperature in the front down part of the vehicles was highest in pigs up to 30kg body weight which could be explained by the higher loading density and/or higher caloric transmission of the piglets to the surrounding. In bovines and sheep < 6 months of age this effect was less prominent.

In sheep > 6 months of age the average front down temperature was lower than the external temperature. This recorded sheep transports took place mostly in summer.

As regards number of animals loaded, information was obtained for each journey. However, without having more precise information how the load was distributed within the vehicles, a correlation between loading density and measured temperatures in the different parts of the vehicle could not be established.

- *Up to around 20°C, the presence of animals in a transport vehicle could be detected by the difference between the sensor in the front down part of the vehicle and the external or other internal sensors.*
- *The recorded data indicate that above around 20°C the presence of animals seems not to add significantly to temperature measured by the external sensor.*
- *The findings confirm previous studies that the lower front part of animal transport vehicles are less ventilated.*

Variation of relative humidity

The negative correlation between temperature and humidity shows that under the climatic conditions under which the recorded journeys were carried out there were only few cases with high temperature and high relative humidity.

The observed decrease of the degree of humidity during animal journeys could be explained by the higher ventilation during movement of the vehicle.

7.3 RECORDED TEMPERATURES IN RELATION TO THRESHOLDS

The overall picture regarding temperatures recorded above the upper and below the lower threshold shows a substantial number of animal journeys with at least one non-compliant temperature record. The temperature thresholds proposed in the EFSA opinion would result in general in a higher percentage of non-compliant conditions, more prominent for the lower temperature threshold for which the non-compliances would almost double compared to the thresholds laid down in Regulation (EC) 1/2005. The table below lists for all journeys and all animal categories the percentage of journeys with at least one non-compliant temperature occurrence, the average number of non-compliant records during a journey and the percentage of journey time, the non-compliant occurrence was present.

When analyzing the temperature data for all animal journeys in regard to the consecutive duration and the values out-of-range, it can be shown for both, the upper and lower threshold, that the vast majority of non-compliant temperatures recorded against the thresholds in Regulation (EC) 1/2005 are of less than 2 hours duration during the transport and average temperatures of 1-2°C above or below the threshold.

When non-compliant occurrences for a consecutive period of less than 2 hours are excluded, the percentage of non-compliant journeys against EFSA thresholds would decrease from 52% to 27 % for the upper limits and from 44% to 31% for the lower limits.

		% of journeys with at least one case of non-compliant occurrence	Average number of non-compliant occurrences per journey	% of journey time in which the threshold was exceeded
Upper threshold	**30º C**	**48%**	**11**	**10%**
	EFSA	**52%**	**14**	**13%**
	EFSA ≥ 2h	**27%**		
Lower threshold	**5º C**	**26%**	**7**	**6% - 10% (*)**
	EFSA	**44%**	**15**	**14% - 20% (*)**
	EFSA ≥ 2h	**31%**		

(*) upper value includes simulated results for November – January on the bases of climatic conditions during 2007/2008

Table 7: Recorded non-compliant temperatures in relation to temperature thresholds in force and in relation to proposed thresholds by EFSA

In coherence with the general climatic conditions in Europe, for the low temperature thresholds, the number of non-compliant occurrences is highest from November to March, whereas for the upper thresholds, the number of non-compliances is high from May to September, with the highest values in July. The data for October can not be considered representative due to the small number of journeys recorded for this month.

With respect to the threshold of 30°C, the reasons that out-of-range temperatures where more frequent in pigs up to 30kg body weight and in sheep > 6 months of age could be the higher loading density and/or higher caloric transmission of the piglets to the surrounding and the fact that most sheep transports were recorded in the summer season as explained under chapter 7.2 – presence of animals.

Setting the upper thresholds lower as proposed by EFSA would cause a sharp increase in non-compliance in pigs > 30 kg body weight from around 10 to 37% and in sheep > 6 months of age from 19 to 36%. In contrary, the higher upper threshold in pigs < 30 kg body weight and young sheep would reduce non-compliance substantially. In cattle transports, the thresholds proposed by EFSA would be different only at a humidity >80%, which did not occur frequently in the recorded period. In fact, the percentage of non-compliance would not change very much compared to the threshold laid down in Regulation (EC) 1/2005

With respect to the threshold of 5°C, the percentage of out-of-range temperatures nearly double in cattle > 6 months of age compared to most other categories. This is most likely influenced by the transports to Russia. Due to the very few transports the high percentage of non-compliance in goats has to be seen with caution.

With the higher temperature proposed for the lower threshold by EFSA, the times of out-of-range temperatures would increase in pigs up to and above 30kg body weight and in sheep < 6 months of age substantially. In pigs < 30kg the non-compliant times would increase from below 5% to over 30%, in pigs > 30kg from 6 to 19 %, in sheep < 6 months from 5 to nearly 25%. Changing the lower threshold from 5°C to 0°C in cattle over 6 months of age, out-of range temperatures would fall from around 10% to around 2%.

- *From the recoded data, EFSA limits would result in general in a higher level of non-compliances in regard to temperatures. In respect to the threshold for low temperatures, the level of non-compliances would double. This increase of non-compliance would become significant for some categories of animals, such as pigs of both weight groups and sheep < 6 months of age.*
- *In order to assess the relevance of out-of-range temperatures in respect to welfare the consecutive duration and the values out-of-range should be taken into account.*

7.4 Temperature-humidity index - THI

Although in the vast majority of records during animal journeys the THI did not exceed 74 (~88%), in nearly 8 % the THI reached values up to 78 and in 4% of records more than 79.

When analyzing THI values above 74 in regard to their consecutive duration, it can be seen that only in extremely few cases a high THI lasted for more than 10 hours. In cattle, values above 79 are considered to be relevant for welfare if animals are exposed to these values over days. While in cattle thresholds for the THI are well established, for other species very little information is available in respect to acceptable THI values and duration. As pigs do not have sweat glands, it is assumed that welfare relevant thresholds for THI values are lower in pigs than in cattle.

- *In very few cases THI values above 74 have been experienced in animal transports lasting over a prolonged consecutive period (> 30 hours).*
- *In order to assess the welfare implications of THI in animal transports, more information would be needed for other species than cattle about acceptable THI thresholds and durations.*

7.5 IMPACTS ON THE TRADE FLOWS

Given the main flows of livestock between northern and eastern parts of Europe on the one side and middle and southern Europe on the other, both, the upper and the lower temperature limits are of concern for the trade. Regarding seasonal distribution, only journeys in April, May and October had less than 10% of non-compliant occurrences against the thresholds of 5°C and 30°C.

Applying the EFSA proposed limits and counting non-compliant occurrences for 2 consecutive hours or more, over the year, around 30% of journeys would be not compliant, with a slightly lower non-compliance in the summer season than in the winter season. The value of non-compliant journeys might become higher when records for a full winter season will be available.

In this study, journeys from Denmark and the Netherlands to Germany, Italy and Spain represented the most dominant trade flow of pigs up to 30kg. Since the effect of non-compliant occurrences for less than 2 consecutive hours is less dominant for the lower temperature thresholds, even with that threshold in duration a substantially high percentage of journeys on this trade flow could produce non-compliant occurrences. For pigs of more than 30 kg the limit proposed by EFSA for the lower threshold with a duration of 2 hours or more would cause a higher percentage of non-compliant occurrences than the threshold of 5°C.

For cattle and horses the EFSA limits with a threshold in duration of 2 hours would produce rather less non-compliant occurrences than measured in the study against the thresholds in force (5°C and 30°C).

For all other categories of animals the impact of the EFSA proposed temperature thresholds on the main trade patterns has to be seen with caution as the number of journeys is relatively small and the recorded conditions may not statistically representative for all climatic conditions along the animal flows.

General temperature data for Europe show that conditions with minimum temperatures below 5°C are around 5 times more frequent than above 30°C. However, the main flows of animals are related to geographical areas which are characterized by moderate or warmer climate. Taking into account predicted climate changes in Europe towards milder winters and more extreme conditions in summer it could be likely that non-compliant journeys for the lower limits decrease whereas non-compliant journeys for the upper limits increase.

Since the temperatures in animal transports recorded in this study were influenced by a number of factors, such as time of the day, short term temperature fluctuations, transport route used, ventilation, etc., the impact of long term climatic conditions on the extent of non-compliant journeys can not be quantified.

The study put emphasis on providing a realistic picture of the situation in commercial animal transports which implied not having full control on the ventilation regimes and possible other measures taken during the animal journeys to improve animal welfare conditions. Therefore, no conclusions can be drawn on their impact on the recorded temperatures or their effectiveness to control acceptable temperature ranges.

ANNEX I REVIEW ON STUDIES REGARDING TEMPERATURE DURING ANIMAL TRANSPORT

Since the two scientific opinions regarding temperature ranges in livestock transport were adopted in 1999 and 2004, some more studies were carried out in which temperatures experienced in animal transports were measured. Some of the studies covered commercial transports whereas others were performed under experimental conditions.

In the United Kingdom the effects of fan-assisted and natural ventilation of the vehicles on body temperatures in pigs were compared[6]). The study refers to 3 three-hour transports in summer (late June) followed by a one-hour stop before unloading. Body temperatures were measured on animals placed on the lower two decks of a three-deck articulated truck.

In another project in the United Kingdom on long distance road transports a mathematical model has been developed to predict the internal environment in the animal compartments of an animal transport vehicle, using the measurements of air temperature and humidity. The project was also aimed to understand how effective ventilation for all animals throughout the whole journey period can be achieved. The air temperatures with mechanical ventilation during transports of pigs, sheep and claves laid between around 5º C (air inlet) and 22º C (air outlet). The study concluded with the need to collect also data under hot and cold conditions, as e.g. in Spain or Sweden[7]).

From the above, in Spain some research focused on microclimate within livestock transport vehicles under hot climate. In July 2004, 2 journeys with pigs and 2 with lambs were monitored to study the behaviour of the transported animals. An example is given that during a journey from morning until afternoon, including a 2 hours break around lunch time, the temperatures in the compartments with pigs were kept between 15º C (air inlet) and 25 º C (air outlet) with mechanical ventilation [8]).

In a thesis from 2006[9]) the thermal conditions in 15 long journeys from Germany to Italy (July to October) were examined. With an external temperature between -0.8 to 28º C during the transports, average temperatures on the 4 sensors in the two vehicles varied between 5 to 30.8º C. The highest average temperature was measured in the lower front compartment (32.7º C) and the lowest average temperature on the upper rear compartment (4.1º C), both during the period of loading. From the measured data the temperature-humidity-index (THI) was calculated. While most time the THI was in an acceptable (THI <74) to moderate range (THI <78) it increased during loading and stops of the vehicles to reach for short periods even levels of serious health risks (THI >84). Highest THI levels are observed in August and in the upper tier.

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6) P.D. Warris, S.N. Brown, T.G. Knowles, L.J. Wilkins, S.J. Pope, S.A. Chadd, P.J. Kettlewell, N.R. Green – Comparison of the effects of fan-assisted and natural ventilation of vehicles on the welfare of pigs being transported to slaughter; Veterinary Record, Vol. 158, issue 17, 29 April 2006, p. 585-588

7) DEFRA/UK – Long distance road transport of farm animals – final project report, MAFF project code AW0808; http://randd.defra.gov.uk/Document.aspx?DocumentID=3148/

8) M. Villarroel – Behavior of pigs and lambs during 8 hour journeys in hot climate – AATA conference 2006 Amsterdam

9) C. Brüser-Pieper – Untersuchung zur thermischen Belastung von Schlachtrindern beim Strassentransport auf Langstecken – Inauguraldissertation, Institut für Tierhygiene, Tierschutz und Nutztierethologie der tierärztlichen Hochschule Hannover, Hannover 2006

In 2007 a project on optimisation of ventilation in livestock trailers commissioned by the UK Department for Environment, Food and Rural Affairs (DEFRA) should be completed with the development of a model for internal and external air flows in small livestock trailers. No results have been yet made available.

Some Swedish research focused on the different ventilation measures to improve welfare during the warm season in Sweden[10]), [11]). These studies give valuable understanding how ventilation may improve the conditions in the animal compartments under relatively moderate summer temperatures. Another study[12]) measured amongst others the temperatures in commercial cattle transports in Swedish summer and winter conditions. While during summer transports the temperatures remained in the animal compartments well within the legally acceptable range, under very cold outside temperature (-16.1º C) it took up to 2 hours until the inside temperature reached 0º C or more. The lowest temperatures were measured in the penultimate pen of a 4 pen transport vehicle. However, on the 4th pen (in the back of the vehicle) no temperature sensor was located.

A study carried out in Sweden[13]) over one year (2004/2005) to reduce mortality by optimizing pig transport vehicles measured the temperatures at different points in and outside the vehicles. During the study the measured outside temperatures varied between well below 0ºC and around 20ºC. Under the Swedish climatic conditions, the study found that the differences between inside and outside temperatures were largest at low temperatures. The highest inside temperatures were in the front of the lower tier and the lowest in back of the lower tier. During stops the temperatures in the lower front part were around 3-5 ºC higher than in the rear. The temperatures between lower and upper tier showed little differences (up to 1.2ºC). The mortality was highest at temperature ranges of 11-15ºC and 21-30ºC. It is concluded that optimized execution of the transport and ventilation (openings, automatic mechanical ventilation at ≥ 20ºC) reduce mortality in transport.

In 2007, a Danish/German group reported trials measuring amongst others temperatures at 42 different points in all 3 tiers of a truck and trailer transporting pigs[14]). The study covered 12 journeys of 6-10 hours with piglets, slaughter pigs and sows from Denmark to Germany. For each category of animals 2 journeys took place in summer with up to 25º C and 2 in winter with around 0º C). The temperatures measured in the vehicles were well within the range of 5º to 30º C (± 5º C). Although by far the most pigs are transported in Europe from Denmark to Germany, those journeys under relatively moderate climatic

[10]) K. Saellvik, J. Krafft, J. Svendsen, K-H. Jeppsson, G. Gustafsson, D. Rantzer - Experiences from studies of pig transport during summer in Sweden – NJF Seminar No 361, Alnarp Seden, 21-22 November 2005

[11]) J. Krafft 2005 – Climate in animal transport vehicles with fattening pigs during summer – a comparison between natural and mechanical ventilation; Swedish University of Agricultural Sciences; Department of Agricultural Biosystems and Technology; Exam thesis, No. 18, Alnarp

[12]) I. Wikner, G. Gebresenbet, C. Nilsson – Assessment of air quality ina comercial cattle transport in Swedish summer and winter conditions – Deutsche Tieraerztliche Wochenschrift, 110,81-132, issue 3, March 2003, p.100-104

[13]) L. Christensen, K. Jonsson – Optimization of transport conditions in relation to transport mortality – Report, 1 April 2007, Project no.: 02763, 40329.1, LCh/ ML - Danish Meat Association

[14]) L. Christensen, L. Blaabjerg and J. Hartung - Investigation of pig transports for more than 8 hours in cold and warm weather conditions and of the requirements for ventilation during transport – Report 24 July 2007, Project no.: DS02770, SF: 42875.1, LCh/LOB/ML - Danish Meat Association

conditions and relatively short distances may not sufficiently reflect the temperatures pigs may be routinely exposed to during journeys in Europe.

Until 2009 a project commissioned by DEFRA should amongst others also determine the range of thermal conditions for breeder pigs encountered during transcontinental road transport. The project involves research groups from the UK and Spain and commercial hauliers of breeder pigs in the UK.

ANNEX II PLANNING, PREPARATION AND EXCECUTION

II.1. Species / categories of animals and temperature thresholds

The following animal species and categories are included in the study:

1. Pigs up to 30 kg
2. Pigs of more than 30 kg
3. Bovine animals up to 6 months of age
4. Bovine animals of more than 6 months of age
5. Sheep of up to 6 months of age and goats
6. Sheep of more than 6 months of age
7. Horses

The recorded temperatures have been compared with the following thresholds.

Species	Type/ weight /age	Temperature range in force (Reg.(EC) 1/2005)		Temperature ranges recommended by EFSA		
		Minimum (ºC)	Minimum (ºC)	Minimum* (ºC)	Maximum adjusted for humidity (ºC)	
					RH <80 %	RH >80 %
Pigs	≤ 30 kg	5 (±5)	30 (±5)	14	32	29
	>30 kg			10	25 (30)*	25 (30)*
Cattle	≤ 6 months			5	30	27
	>6 months			0	30	27
Sheep	Full fleece			0	28	25
	Shorn			10	32	29
Goats				6	30	27
Equidae				-	-	-

*with mechanical ventilation and misting devices

Table II.1: Acceptable temperature ranges for different species/categories of animals in force and recommended by EFSA (thresholds for pigs < 10kg and cattle < 2 weeks not shown)

II.2. Mathematical models and statistical analysis applied

Statistical analysis of the data was carried out using the statistical software R[15]. Correlations were calculated using Pearson product-moment correlation coefficient, (covariance of the two variables divided by the product of their standard deviations).

Scatter plots with frequency distributions were obtained using the package simpleR[16] . Climatic data were obtained from JRC – IPSC Agriculture Unit[17].

[15]) Copyright (C) 2008 The R Foundation for Statistical Computing ISBN 3-900051-07-0

[16]) Copyright John Verzani (verzani@math.csi.cuny.edu), 2001-2. All rights reserved.

[17]) Interpolated meteorological data Source JRC/MARS - Meteorological Data Base - EC - JRC.

II.3. Organisations, institutions, companies and persons contacted

European Commission
- TRACES database (DG SANCO / D1)

- Food and Veterinary Office (DG SANCO / F6 – animal welfare inspection group)

- EUROSTAT http://epp.eurostat.ec.europa.eu/

Carrozzeria Pezzaioli srl
Via Primo Levi 6, 25018 Montichiari (BS)

Associazione Trasportatori Bestiame - Asso.Tra.Be
Via F.lli Silvestro, 1
12020 Madonna dell'Olmo – Cuneo

UECBV
Rue de la Loi 81A, 1040 Brussels

Fédération National des Transport Routier - FNTR
6 rue Ampère, 75017 Paris

European Livestock Transporters ELT / Transport en Logistiek Nederland
Boris Pasternaklaan 22
Postbus 3008, 2700 KS Zoetermeer

Road Haulage Association Ltd
Roadway House, 35 Monument Hill
Weybridge, Surrey KT13 8RN

Bundesministerium für Ernaehrung, Landwirtschaft und Verbraucherschutz,
Referat Tierschutz
Rochusstrasse 1, 53123 Bonn

Arbeitsgemeinschaft Deutscher Rinderzüchter e.V. - ADR
Adenauerallee 174, 53113 Bonn

Bundesverband Deutscher Tiertransporte - BDT
Bockhorstr. 6, 49455 Voltlage

Animal transport companies from

Denmark, France, Germany, Greece, Hungary, the Netherlands, Poland, Spain
Confidentiality has been guaranteed to the participating companies in order to protect their trade data and commercial interests.

II.4. Animal flow and journeys to be included in the study

The flow of pigs, cattle, sheep, goats and horses within the EU in terms of number of transports and number of animals were established from TRACES data for 2005 and 2006.

The distribution of the different species in the long journey transport volume within the EU is shown in the table below.

2005 – long journeys in intra-Community trade (ICT)						
% of:	**pigs**	**cattle**	**sheep**	**goats**	**Horses**	**total**
Transports	29,4%	57,8%	5,7%	0,3%	7,4%	100%
Animals	57,6%	22,7%	18,5%	0,3%	0,9%	100%

2006 – long journeys in ICT						
% of:	**pigs**	**cattle**	**sheep**	**goats**	**Horses**	**total**
Transports	33,1%	54,7%	4,8%	0,4%	7,0%	100%
Animals	67,5%	18,6%	12,5%	0,8%	0,6%	100%

Table II.1: Representation of the different species in the long journey transport volumes in intra-Community trade (TRACES 2005 and 2006)

Since the data from TRACES did not allow further differentiation of categories within a species, e.g. pigs below or above 30 kg of life weight, cattle below or above 26 weeks of age, additional information from the animal welfare group of the Food and Veterinary Office of DG SANCO was used. Regarding the number of animals transported in 2006, the most important flows in long journeys for pigs, cattle, sheep, goats and horses can be summarized as follows (the major routes which should be included in the study are highlighted in green).

- **pigs**

Origin	Destination	% of all pigs transported in 2006	
Denmark	Germany	41 %	of ICT
Netherlands	Spain	11 %	of ICT
Poland	Hungary	6 %	of ICT
Netherlands	Italy	5 %	of ICT
Denmark	Poland	3 %	of ICT

Table II.2: The five most important flow patterns in % of all pigs transported in intra-Community trade in 2006 (TRACES 2006)

According to the FVO there are big assembly centers in the Netherlands from where piglets go to Spain and Italy. Pigs > 30kg go mainly from the Netherlands to southern parts of Italy.

- **cattle**

Origin	Destination	% of all cattle transported in 2006	
France	Italy	17 %	of ICT
Poland	Italy	10 %	of ICT
Poland	Spain	9 %	of ICT
Poland	Netherlands	6 %	of ICT
France	Spain	4 %	of ICT
Ireland	Spain and Italy	3 %	of ICT

Table II.3: The six most important flow patterns in % of all cattle transported in intra-Community trade in 2006 (TRACES 2006)

According to the FVO, transports from Poland to the Netherlands and Italy are mainly calves and there is an important flow of cattle > 6 months from France and Germany to Russia (export).

- **sheep**

Origin	Destination	% of all sheep transported in 2006	
Hungary	Italy	18 %	of ICT
Hungary	Greece	7 %	of ICT
France	Italy	5 %	of ICT
Spain	Italy	4 %	of ICT
Romania	Italy	19 %	of imports
Romania	Hungary	11 %	of imports
Romania	Spain	3 %	of imports

Table II.4: The most important flow patterns in % of all sheep transported in 2006 in intra-Community trade and import to the EU, respectively (TRACES 2006)

According to the FVO, sheep < 6 months are mainly transported from Hungary to Italy around Christmas and Easter and from Romania to the Netherlands from where they go further to France or other Member States. Sheep > 6 months are frequently transported from Spain to Greece and from Hungary to Italy. Information from animal welfare groups suggested that there should be also a flow from the UK to Greece.

- **goats**

Origin	Destination	% of all goats transported in 2006	
Netherlands	Spain	60 %	of ICT
Netherlands	France	15 %	of ICT
France	Italy	6 %	of ICT
France	Greece	4 %	of ICT

Table II.5: The most important flow patterns in % of all goats transported in 2006 in intra-Community trade (TRACES 2006)

The transport of goats presented less than 1% of all intra Community trade in livestock.

- **horses**

Origin	Destination	% of all horses transported	
Poland	Italy	36 %	of ICT
France	Italy	11 %	of ICT
Spain	Italy	11 %	of ICT
Hungary	Italy	5 %	of ICT
Lithuania	Italy	2 %	of ICT
Romania	Italy	12 %	of imports
Bulgaria	Italy	4 %	of imports

Table II.6: The most important flow patterns in % of all horses transported in 2006 in intra-Community trade and import to the EU, respectively (TRACES 2006)

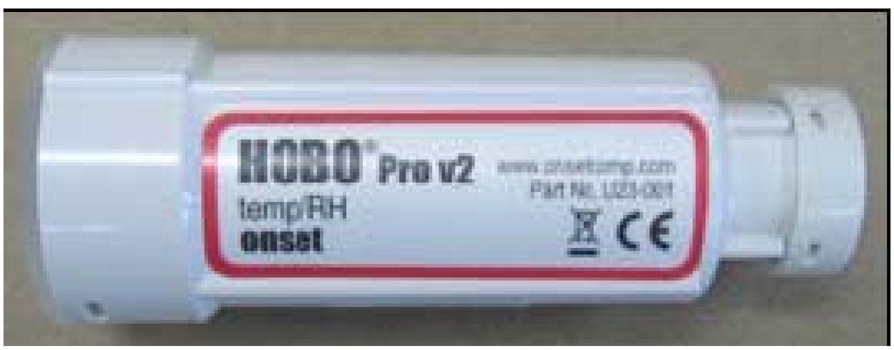
ANNEX III TEMPERATURE/HUMIDITY RECORDING SYSTEM

III.1. Specifications of data loggers with integrated temperature and humidity sensors (HOBO Pro v2 U23-001)

- Temperature measurement range: -40°C to +70°C
- Temperature measurement accuracy: ±0.2°C (between 0 – 50 °C)
- Temperature measurement resolution: 0.02°C (at 25°C)
- Stability (drift) <0.1°C per year

- Relative humidity (RH) range: 0 – 100%
- RH measurement accuracy: ±2.5% (between 10 – 90 % RH)
- RH measurement resolution: 0.03%
- Stability (drift) <1% per year

- Power supply: rechargeable battery
- Memory: 64Kbytes (~ 21.000 measurements)
- Real-time clock: ±1 min/month (between 0 – 50 °C)



Picture III.1: Data logger with integrated temperature and humidity sensor

The memory of the data loggers used allows around 5-6 months of data recordings in 15 minutes intervals. When plugging to the data loggers for downloading records, their functioning was checked and the memory was cleared. In this way, from the initially 113 data loggers installed, 10 data loggers were replaced during the study:

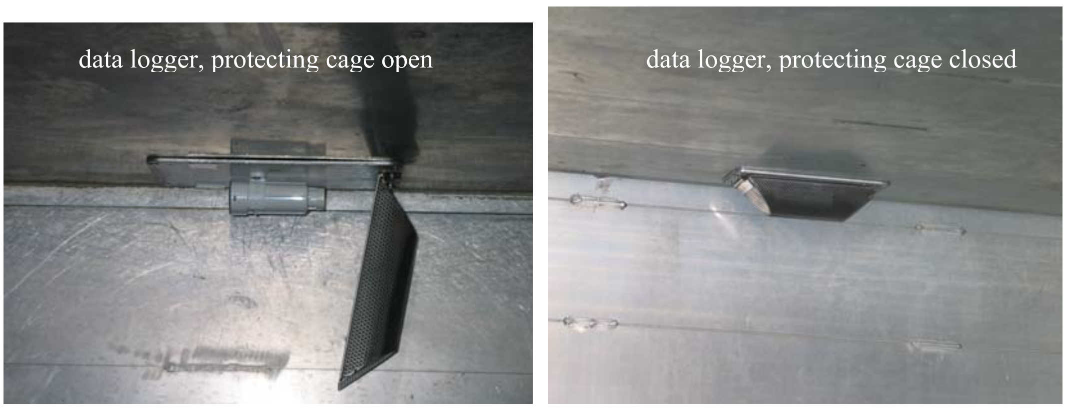
- 1 data logger after some months was damaged by animals;
- 4 data loggers in the lower tier of 2 vehicles of 1 company after having stopped functioning - 6-8 weeks after installation, the humidity sensors did not measure any variation in humidity (100% saturation) and 5-6 months after installation also the temperature sensors stopped functioning;
- 4 data loggers showed after the winter period low battery values;
- 1 data logger could not be recovered when the vehicle was replaced.

III.2. Schematic layout for positioning the temperature/humidity sensors

In order to avid bias and deception, the data loggers were installed and download of recorded data from the loggers were carried out by JRC staff in accordance with the following predefined rules:

- not to install in direct flow of a mechanical ventilator,
- front sensors, median, 15-20 cm behind the front panel of the animal compartment and parallel to the first natural ventilation opening,
- back sensors, lateral 15-30 cm before the back panel of the animal compartment, parallel to the last natural ventilation opening,
- between the protecting cage for the sensors/data logger and the metal panels of the compartment stripes of adhesive foam (~ 0,5cm thick), between sensors and underlying metal constructions ~ 3cm distance.

The outside temperature/humidity sensor was fixed underneath the loading compartment of the vehicle, protected from heat sources, in particular from direct sunlight and the motor of the towing vehicle, in order to record the ambient temperature and relative humidity.

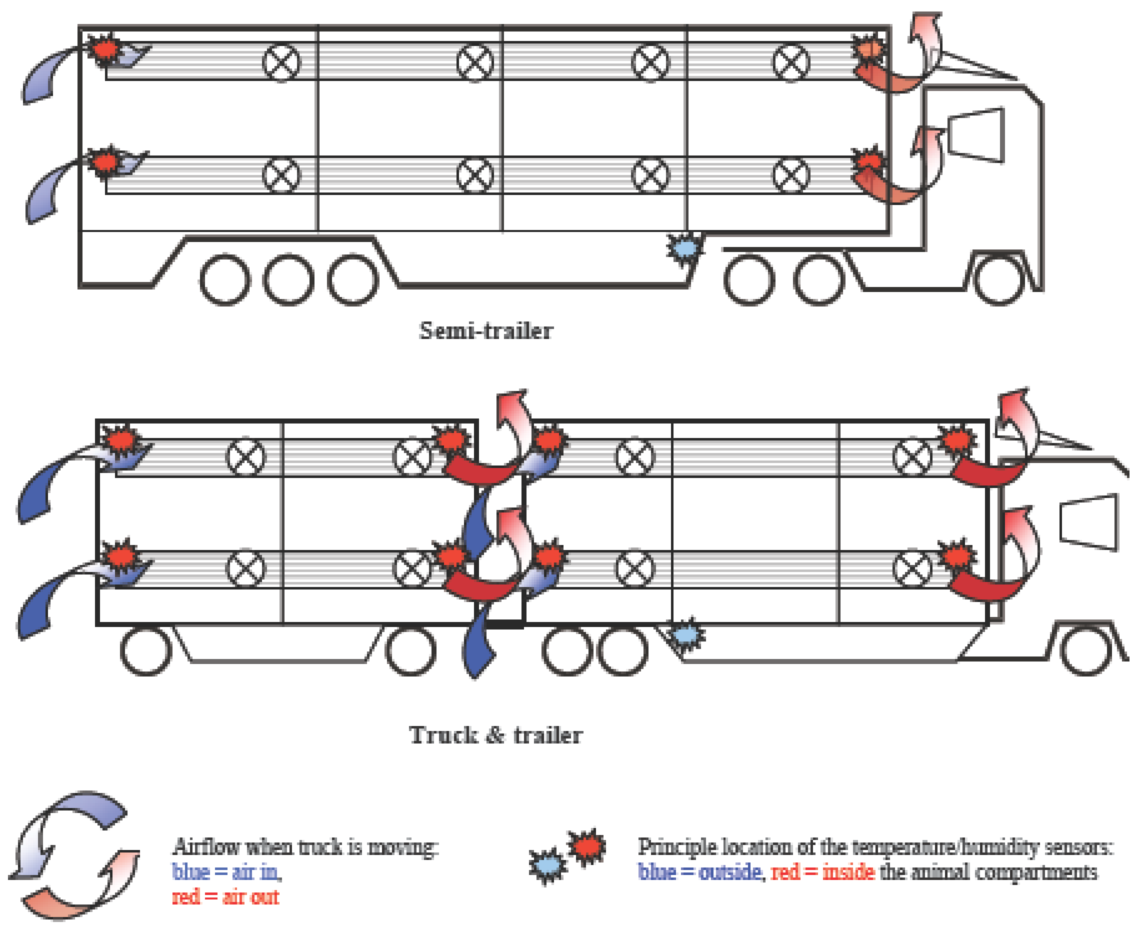


Picture III.2: Example of a data logger, installed in the front of the animal compartment on the ceiling of the lowest tier (protecting cage open / closed)

Picture III.3: Example of a data logger, installed under a semi-trailer for recording external temperatures/humidity

In principle the recording devices were installed as follows (see schematic drawings below):

- 4 data loggers in the animal compartments of the vehicles
  - ➢ in vehicles with 1 floor (mono-volume), 1 median in the front and 1 lateral in the back, both ~ 1m above the floor, 1 median in the front and 1 lateral in the back, both close to or under the roof,
  - ➢ in multi-tier vehicles, 1 median in the front and 1 lateral in the back, both on the ceiling of the lowest tier, 1 median in the front and 1 lateral in the back, both close to or under the roof,
- 1 data logger under the vehicle for the ambient temperature.



Picture III.4: Schematic layout for the installation of data loggers / sensors in semi-trailers and trucks; the drawings shows also the position of data loggers / sensors in the two trailer which were equipped for the study

Within the reported period of the study, 3 of the originally participating vehicles were substituted by other vehicles and the recording devices reinstalled:

- 1 truck for horses was sold and substituted by a new truck,
- 1 semi-trailer for pigs was sold and substituted by a truck and trailer,
- 1 semi-trailer for cattle was replaced by another semi-trailer.

III.3. Information given to participating transport companies and drivers

Each transport company participating in the study received from JRC a short description of the study and instructions on the collection, format and transmission of additional information on paper, either in English, French or Italian. The English version is shown below

JRC provided the participating transport companies/drivers a short training how to collect the data and operated for the participants a helpline for the period of data collection (at least 8 hours during working days).

JRC
EUROPEAN COMMISSION

ipsc
Institute for the Protection and Security of the Citizen

INFORMATION

ON THE

PROJECT

"STUDY ON TEMPERATURES DURING ANIMAL TRANSPORT"

IN THE FRAME OF AN ADMINISTRATIVE ARRANGEMENT
BETWEEN
DG SANCO AND JRC

JRC / IPSC 1 / 14 Version 0.1 – 15/01/2008

European Commission
Joint Research Centre
Institute for the Protection and Security of the Citizen

Ispra, January 2008

Dear participants in the temperature study,

This document provides you some useful information and the necessary details of the temperature study in long journey animal transports. If you should need any additional information you can feel free to contact us anytime at the address below.

Contact information
Address: TP 361, Via E. Fermi 1, 21027 Ispra (VA) / Italia
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1. WHY THIS STUDY?

Animals may be exposed during transportation to temperatures which are likely to compromise their wellbeing, influenced very much by regional and/or seasonal climatic conditions, the time of the day and the length of the journey.

Two scientific opinions on temperature standards for the transport of animals were adopted in 1999 and in 2004. The present standards do not reflect those scientific opinions.

With the adoption of Regulation (EC) No 1/2005, the Council gave to the Commission the mandate of establishing a new range of maximum and minimum temperatures for the transported animals. At the end of 2006, the Commission submitted a draft regulation on temperature standards at the Standing Committee on the Food Chain and Animal Health as to reflect the latest scientific opinion. However, most Member States did not support the proposed figures.

Most delegations were uncertain on the consequences of the new standards and they suggest postponing the adoption of new temperature standards until they receive more information on their possible impacts. The existing studies can not easily be extrapolated to the routine animal transports within the whole of Europe.

Therefore, the European Commission asked its Joint Research Centre (JRC) to measure temperatures in routine commercial animal transports along the main flow patterns, reflecting also the variety of the climatic conditions in the different parts of the EU.

2. WHAT ARE THE ADVANTAGES FOR THE TRANSPORT COMPANIES IN PARTICIPATING?

The participating transport companies will be provided twice during the study (after March and again after July) with the detailed data collected from their own vehicles with a short analysis in relation to the temperature thresholds. Transport companies can not get a financial contribution from JRC for their participation.

Beside the direct information for the own vehicles, the results of the study could be very helpful to provide sound data for the discussions about the consequences and impacts of the temperature thresholds proposed by the Commission for the routine commercial transports in Europe.

3. FOR HOW LONG THE STUDY WILL BE CARRIED OUT?

The study should cover winter and summer conditions. It is planned to collect temperatures and relative humidity from the participating vehicles from 1 February to the end of July.

4. WHAT JOURNEYS ARE INCLUDED IN THE STUDY?

The study is limited to the commercial transport of **pigs**, **cattle**, **sheep**, **goats** and **horses** on **journeys exceeding eight hours** and that **involve at least two Member States**.

The study will be carried out for 7 categories of animals:

1. Pigs up to 30 kg
2. Pigs of more than 30 kg
3. Bovine animals up to 26 weeks of age (calves)
4. Bovine animals of more than 26 weeks of age
5. Sheep of more than 6 months of age (long fleece, unshorn)
6. Sheep of up to 6 months of age (lambs) and goats
7. Domestic equidae (horses, donkeys and alike)

The study covers the following routes:

From	To	Category of animals
Poland	Spain	calves < 6 months
Poland	Italy	calves < 6 months
France	Italy	cattle > 6 months
France/Germany	Poland (export to Russia)	cattle > 6 months
Netherlands	Spain	pigs < 30 kg
Netherlands	Italy	pigs < 30 kg
Denmark	Poland	pigs > 30 kg
Netherlands	Italy	pigs > 30 kg
Romania	Spain	sheep < 6 months
Hungary	Italy	sheep < 6 months
Spain	Greece	sheep > 6 months, goats
Hungary	Italy	sheep > 6 months, goats
Poland	Italy	horses
Romania/Bulgaria	Italy	horses

5. HOW THE TEMPERATURES AND RELATIVE HUMIDITY WILL BE RECORDED?

The temperatures and relative humidity will be recorded and colleted from the animal compartments and at the outside of long journey transport vehicles with **data loggers with built in temperature/humidity sensors**. The data loggers are protected with a metal shield which will be fixed with 4 rivets to the metal construction of the vehicle and will not harm the animals. The specifications are listed in Annex I.

Each participating truck will be fitted with **4 data loggers inside** the animal compartments and **1 data logger outside**. As the inside temperatures in the front area of a transport vehicle in movement are mostly some degrees higher than in the rear, two temperature/humidity loggers will be located in the front and two in the rear part of the animal compartments. One outside temperature/humidity logger will be fitted underneath the loading compartment of a truck, protected from heat sources, in particular from direct sunlight and the motor of the vehicle, to record the ambient temperature and relative humidity. Although most long journeys are carried out with semi-trailers, some trucks with trailers have been selected where the trailers will also be fitted with data loggers to record the inside temperatures.

In principle, the data loggers will be installed as displayed in Annex II. In the lowest tier, they will be fixed on the ceiling (underside of the above tier), in the upper tier directly under the roof (underside of the roof). In vehicles with one level only, the data loggers in the lower part of the loading compartment will be fixed to the front panel and the rear door respectively.

Before the study JRC will install on its own expenses the devices on the participating vehicles and remove them at the end of the study. The participating transport companies will be contacted by JRC to find a suitable date for the installation/removal of the equipment.

Your vehicles are already equipped with a temperature recording system

Many of the trucks are already fitted with temperature monitoring systems. Since the number and location of temperature sensors of the installed systems vary considerably we would urge the participating transport companies to allow the installation of the above described data loggers also if the trucks have their own recording systems. Otherwise the temperatures and relative humidity recorded from the different trucks could not be easily compared and that would compromise the study.

6. HOW THE RECORDED TEMPERATURES AND HUMIDITY WILL BE RECOVERED?

JRC will download the recorded data from the trucks once after the winter period and again, when the data loggers will be removed. The participating transport companies will be contacted by JRC to find a suitable date for the download.

During the study, the transport companies should send for each journey of the participating vehicle on the selected route and category of animals a copy of the journey log to JRC (e.g. journey log of truck A for the journey Denmark-Poland with pigs >30kg, but not for other journeys truck A may carry out). In addition, JRC would ask the drivers to provide if possible some information to the journey regarding bedding, ventilation, misting devices (or an example of such supplementary questions see Annex III). JRC would provide the participating companies and drivers with a brief oral introduction how to enter the information.

Your vehicles are already equipped with a navigation system

Instead of a copy of the journey log, a transport company which has the participating vehicles equipped with a navigation system could provide JRC details about the journeys (point of departure, route, destination, category and number of animals transported) also electronically.

7. WHAT OTHER DATA AND INFORMTION WILL BE RECORDED AND HOW THEY WILL BE COLLECTED?

While JRC will install the data loggers on the trucks for the period of data collection, it will take the details of the participating trucks regarding:

Type of truck	semi-trailer, truck, truck and trailer, number or tiers, available space for animals on each tier in m^2
Equipment on truck	natural, mechanical ventilation, water, misting devices, rugs
Normal use of truck	categories of animals normally transported, average number of animals loaded of each category on how many tiers, average size, weight or age of transported categories.

8. CONFIDENTIALITY OF DATA AND INFORMATION

The data received from the transport companies for this study will be used anonymously and commercially sensitive data will be treated confidential and not be made available to any third party.

9. WHAT WOULD BE REQUESTED FROM PARTICIPATING TRANSPORT COMPANIES?

JRC asks the participating transport companies that

- JRC can installs to its own expenses on the participating vehicles temperature sensors (in the animal compartments and outside the vehicle) JRC would record some technical details of the vehicle which may have an effect on the temperature (truck & trailer, semi-trailer, type of ventilation, bedding, misting devices, etc.).
- The transport companies use the participating vehicle(s) regularly (preferably 1x per week) for the selected route(s) and category of animals.
- The participating transporters provide JRC with the following details for each long journey of the selected truck for the selected route and category:
    - **Copy of the completed journey log (mandatory)**

      (Planning, information regarding departure and destination, declaration by transporter, anomaly report)
    - **Animal welfare measures taken during a long journey (voluntary by driver)**

(Bedding applied before loading, estimated time when mechanical ventilation was switched on/off, air flaps closed/opened, misting device switched on/off during the journey, other measures).

The above data should be sent by the transport company in regular intervals (e.g. once a month) to the JRC by e-mail, fax or mail.

10. WHAT TECHNICAL SUPPORT IS AVAIALBE DURING THE STUDY?

JRC will operate for the participants a helpline for the period of data collection (at least 8 hours during working days). If you have any questions concerning this document or its application, you can contact us under:

The help line:

(+39) 348 3614043

Or under our address:

TP 361, Via E. Fermi 1, 21027 Ispra (VA) / Italia
E-mail: gianluca.fiore@jrc.it
johann.hofherr@jrc.it
Tel.: +39 0332 78 9053
Fax: +39 0332 78 6280

11. TIME LINE

An overview on the actions and deadlines is outlined below

	actions	deadlines
T 1	**Preparation of the study**	
	Installation of systems in all selected vehicles and verify functioning	January 2008
	Helpdesk for participants	January 2008
T 2	**Performing the collection of data**	
	Data collection	Feb. – July 2008
	Download data after winter and summer period	after March 2008 and after July 2008
	Data processing	March – September 2008
T 3	**Analysis of the data**	
	Data analysis	March – September 2008
T 4	**Report**	
	Feed back to participating transport companies	after March 2008 and July 2008
	Summary report	September 2008

The study will be concluded with a study report with the analysis of the data, conclusions and possible recommendations.

ANNEX I TECHNICAL SPECIFICATIONS FOR THE TEMPERATURE MONITORING

Temperature and humidity sensors

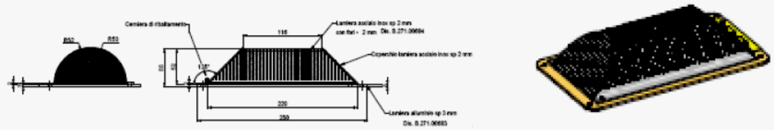
The temperature and humidity sensors will have the following specifications

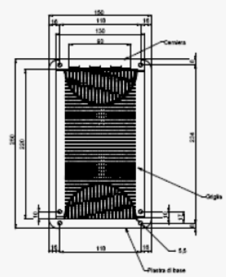
- Temperature measurement range: -40°C / +75°C;
- Temperature measurement accuracy: +/-0.2°C;
- Temperature measurement resolution: 0.02°C.
- Relative humidity (RH) measurement range: 0 – 100%;
- RH measurement accuracy: +/-2%
- Power supply: self powered by rechargeable battery (lasting around 6 months and to recharge in situ).

Protection device for the data logger with the temperature and humidity sensors

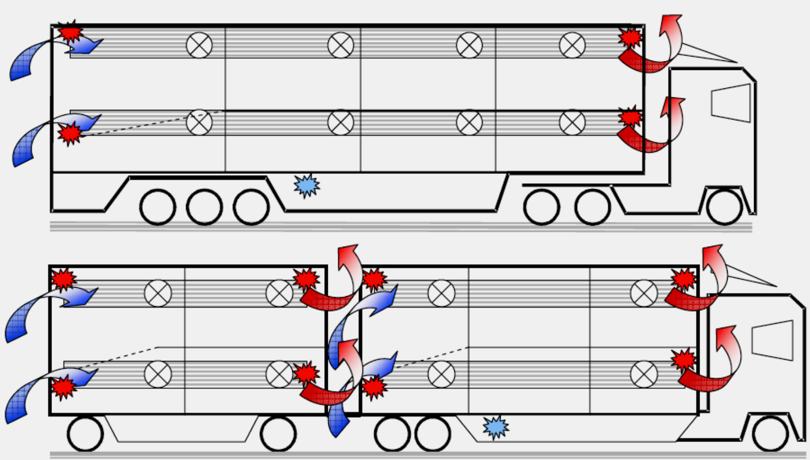
The device consists of two parts:
- a plate in 3mm alloy (15x25cm) on which the data logger will be fixed,
- a cover in 2mm perforated inox steel (12x22cm, 5.5cm high).

The whole device will be fixed on the truck with 4 rivets (to the ceiling of the lowest tier and the underside of the roof).





ANNEX II SCHEMATIC LAYOUT FOR THE TEMPERATURE/HUMIDITY SENSORS



Semi-trailer

Truck & trailer

Airflow when truck is moving:
blue = air in,
red = air out

Natural ventialtion

Mechanical ventilation

Principle location of temperature sensors:
blue = outside,
red = inside

Temperatures in Long Journey Animal Transport Information on study

ANNEX III ADDITIONAL INFORAMTION TO THE RELEVANT JOURNEYS

1. Journey (Viaggio)
Journey log number ______________
(Numero del giornale del viaggio)
Journey from ___/___/2008 to ___/___/2008
(Data del viaggio dal al)
Transport Company
(Società del trasporto)

2. Vehicle (Mezzo di trasporto)
Type of vehicle (Tipo di veicolo): truck (autocarro) | trailer (rimorchio) | semi-trailer (semirimorchio)
Number of tiers loaded (Numero di piani caricati): 1 2 3 4

3. Additional measures taken for journey
(Le misure supplementari adottate per il viaggio)
Vehicle floors covered with (i pavimenti coperti di)
rubber rugs (lettiera di gomma) yes (si)
straw bedding (lettiera della paglia) yes (si)
saw dust bedding (lettiera della segatura) yes (si)
Other measures taken (altre misure adottate) ______________________________

4. Actions taken during journey - ventilation, misting (Provvedimenti presi durante il viaggio – ventilazione, nebbia)

	Day (Giorno) 1								Day (Giorno) 2								Day (Giorno) 3								Day (Giorno) 4								Day (Giorno) 5								
Distribution over the journey (nel periodo del viaggio)	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	Can't remember (non mi ricordo)
Natural ventilation open (Ventilazione naturale aperto)																																									
Mechanical ventilation on (Ventilazione meccanica in funzione)																																									
Misting devices on (Dispositivi della nebbia in funzione)																																									

5. Any observations on devices installed for the study
(Qualsiasi osservazione sui dispositivi installato per lo studio)
one or more temperature sensors damaged / missing (uno o più sensori di temperatura danneggiati/che mancano) yes (si)
____

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Temperatures in Long Journey Animal Transport Information on study

Example how to fill in the additional information

1. Journey (Viaggio)
Journey log number 137/2008
(Numero del giornale del viaggio)
Journey from 14/ 02 /2008 to 16 / 02 /2008
(Data del viaggio dal al)
Transport Company
(Società del trasporto)

2. Vehicle (Mezzo di trasporto)
Type of vehicle (Tipo di veicolo): truck (autocarro) | trailer (rimorchio) | semi-trailer (semirimorchio)
Number of tiers loaded (Numero di piani caricati): 1 2 3 4

3. Additional measures taken for journey
(Le misure supplementari adottate per il viaggio)
Vehicle floors covered with (i pavimenti coperti di)
rubber rugs (lettiera di gomma) yes (si)
straw bedding (lettiera della paglia) yes (si)
saw dust bedding (lettiera della segatura) yes (si)
Other measures taken (altre misure adottate) ______________________________

4. Actions taken during journey - ventilation, misting (Provvedimenti presi durante il viaggio – ventilazione, nebbia)

	Day (Giorno) 1								Day (Giorno) 2								Day (Giorno) 3								Day (Giorno) 4								Day (Giorno) 5								
Distribution over the journey (nel periodo del viaggio)	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	Can't remember (non mi ricordo)
Natural ventilation open (Ventilazione naturale aperto)																																									
Mechanical ventilation on (Ventilazione meccanica in funzione)																																									X
Misting devices on (Dispositivi della nebbia in funzione)																																									

5. Any observations on devices installed for the study
(Qualsiasi osservazione sui dispositivi installato per lo studio)
one or more temperature sensors damaged / missing (uno o più sensori di temperatura danneggiati/che mancano) yes (si)
____

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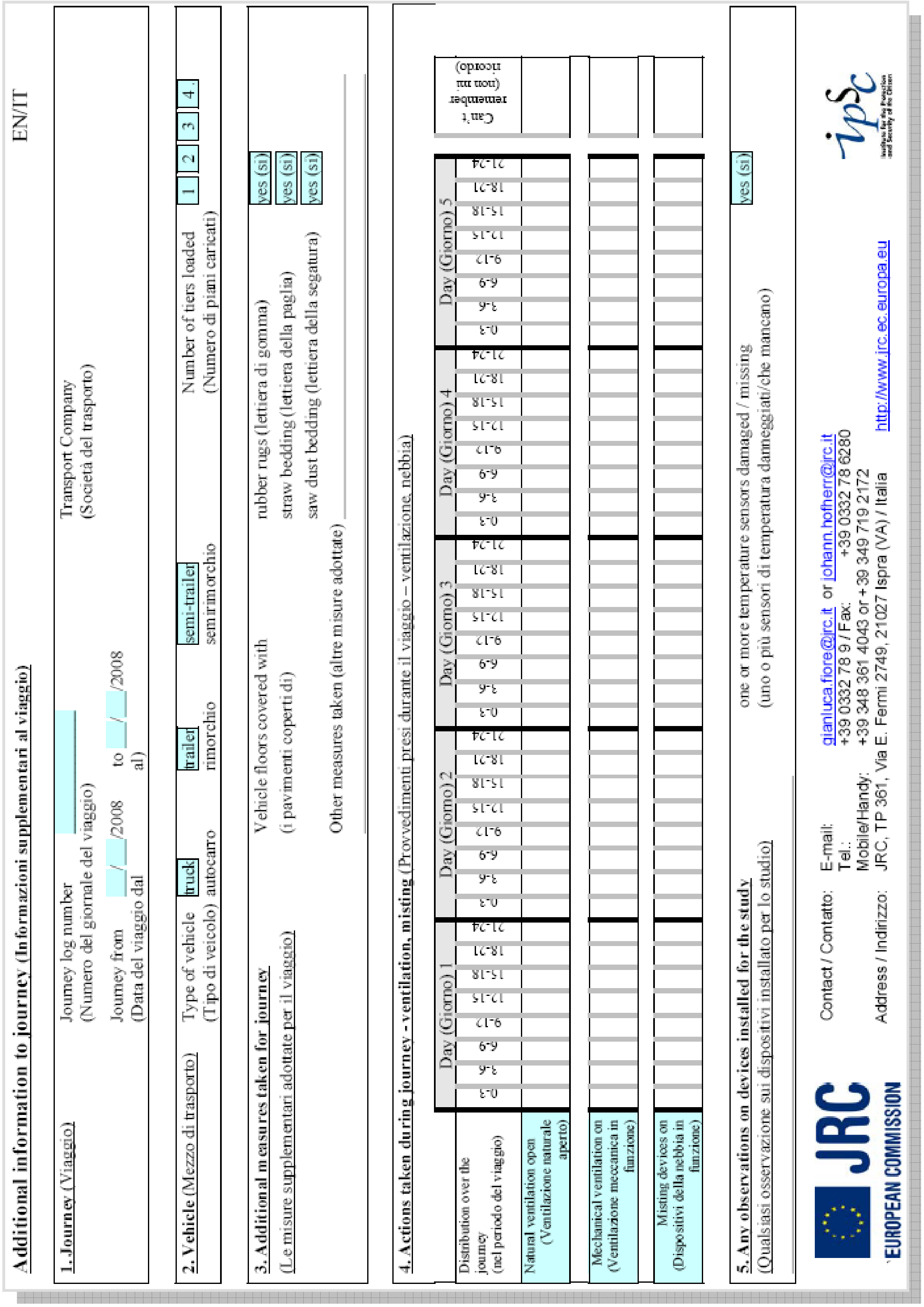
Form requesting additional welfare relevant information for each journey



Additional information to journey (Informazioni supplementari al viaggio) EN/IT

1. Journey (Viaggio)
Journey log number (Numero del giornale del viaggio) ________
Transport Company (Società del trasporto)
Journey from (Data del viaggio dal) __/__/2008 to (al) __/__/2008

2. Vehicle (Mezzo di trasporto)
Type of vehicle (Tipo di veicolo): truck (autocarro) / trailer (rimorchio) / semi-trailer (semirimorchio)
Number of tiers loaded (Numero di piani caricati): 1 2 3 4

3. Additional measures taken for journey (Le misure supplementari adottate per il viaggio)
Vehicle floors covered with (i pavimenti coperti di):
rubber rugs (lettiera di gomma) yes (si)
straw bedding (lettiera della paglia) yes (si)
saw dust bedding (lettiera della segatura) yes (si)
Other measures taken (altre misure adottate) ________

4. Actions taken during journey - ventilation, misting (Provvedimenti presi durante il viaggio – ventilazione, nebbia)

Distribution over the journey (nel periodo del viaggio)	Day (Giorno) 1								Day (Giorno) 2								Day (Giorno) 3								Day (Giorno) 4								Day (Giorno) 5								Can't remember (non mi ricordo)
	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	
Natural ventilation open (Ventilazione naturale aperto)																																									
Mechanical ventilation on (Ventilazione meccanica in funzione)																																									
Misting devices on (Dispositivi della nebbia in funzione)																																									

5. Any observations on devices installed for the study (Qualsiasi osservazione sui dispositivi installato per lo studio)
one or more temperature sensors damaged / missing (uno o più sensori di temperatura danneggiati/che mancano) yes (si)

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Picture III.5: Additional information sheet for journeys to be filled in by drivers (facultative) made available in different languages (EN, NL, DE, IT, FR, ES, PL, RO)

ANNEX IV JOURNEYS COVERED FROM FEBRUARY TO OCTOBER 2008

The recordings used for the study cover the periods indicated for each vehicle in the following table.

Vehicle	From (installation)	To (last download)	Replacement vehicle (installation)	To (last download)
1	02-Feb-08	08-Jul-08	08-Jul-08	20-Oct-08
2	02-Feb-08	04-Oct-08		
3	02-Feb-08	04-Oct-08		
4	04-Feb-08	08-Oct-08		
5	04-Feb-08	08-Oct-08		
6	04-Feb-08	08-Oct-08		
7	04-Feb-08	08-Oct-08		
8	06-Feb-08	26-Sep-08		
9	09-Feb-08	19-Sep-08		
10	09-Feb-08	19-Sep-08		
11	11-Feb-08	22-Sep-08		
12	11-Feb-08	22-Sep-08		
13	11-Feb-08	26-May-08		
14	11-Feb-08	21-Sep-08		
15	12-Feb-08	21-Sep-08		
16	12-Feb-08	26-May-08	26-May-08	23-Sep-08
17	14-Feb-08	25-Oct-08		
18	28-Feb-08	13-Oct-08		
19	13-Mar-08	15-Oct-08		
20	13-Mar-08	08-Jul-08	08-Jul-08	16-Oct-08
21	13-Mar-08	15-Oct-08		

Table IV.1: Periods for which temperature / humidity data recordings were downloaded in 21 vehicles

Of the data downloaded, 278,450 records are related to 515 recorded animal journeys.The following table shows for the different categories of animals the countries of origin and destination as well as the monthly distribution of these 515 journeys.

Category	Origin-Destination	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Pigs <= 30 kg	DE-FR	2									2
	DK-DE	7	1	6	9	4	9	12	7	3	58
	DK-PL						1				1
	IT-HU			1	1		3				5
	IT-RO						1				1
	NL-HR					1		2			3
	NL-ES	6	6	6	7	3	4	1	2		35
	NL-FR			1				1			2
	NL-GR				1		1				2
	NL-HR				1						1
	NL-IT	5	5	7	7	5	9	5	5		48
	NL-PL				2			1	4		7
	UK-IT			1							1
Pigs <= 30 kg Total		20	12	22	28	13	28	22	18	3	166
Pigs > 30 kg	BE-ES								1		1
	BE-FR					1					1
	BE-IT		1			1					2
	DK-DE	2	3		1	2	1	2	2		13
	DK-DK	16	9								25

	DK-ES				1	1	1					3
	DK-GR				1		1					2
	DK-HU				1							1
	DK-IT			1								1
	DK-NL					1						1
	DK-PL			1		1		2	1			5
	DK-RU					1			1			2
	DK-SK							1				1
	FR-DE						1	5	3	1		10
	FR-IT					1	2	1		2		6
	FR-NL	3				6	7					16
	HU-IT			1								1
	IT-DE					2		2				4
	IT-HU							1	1			2
	IT-SK						1					1
	NL-FR			1								1
	NL-IT	1		1	1			1	1	1		6
	NL-PL					1	1		1			3
	NL-RO							1				1
Pigs > 30 kg Total		22		18	4	15	18	15	10	7		109
Bovines < 6 Mo	BE-FR				1							1
	CZ-ES					1						1
	IT-FR		1									1
	LT-ES			1	1	2				1		5
	LT-IT			1				2	1			4
	LT-NL			1	1							2
	PL-ES			2	4	2	1		4	3		16
	PL-IT			3	2	2	2	1		1	1	12
	PL-NL					2						2
	RO-IT		1									1
	UK-BE						2	1				3
	UK-FR					1						1
Bovines < 6 Mo Total			2	8	9	10	5	4	5	5	1	49
Bovines > 6 Mo	AT-RU			1	2							3
	BE-FR								1			1
	CZ-MT								1			1
	DE-CH				1							1
	DE-DE				2							2
	DE-ES		1					1		2		4
	DE-FR			1		2						3
	DE-GR				1		1	1				3
	DE-HR				1							1
	DE-IT									1		1
	DE-PL			1								1
	DE-RO				1							1
	DE-RU		1									1
	DK-AT				1							1
	ES-ES		1									1
	ES-IT				2	2	2					6
	FR-BG				3							3
	FR-IT		6		2	5	2	7	6	6	1	35

	FR-PL									1	1
	FR-RU					1					1
	IT-ES	1	1		1						3
	IT-FR	1									1
	LT-IT					1					1
	NL-BG			1							1
	NL-Morocco					1					1
	NL-RU		1								1
	PL-BG			1							1
	PL-DE		1								1
	PL-IT						2				2
	RO-IT		1								1
	SE-HR					1	2				3
Bovines > 6 Mo Total		11	7	18	10	9	13	8	9	2	87
Sheep < 6 Mo	HU-FR								1		1
	HU-IT	3	5	4	2		2	3	1		20
	PL-IT		2		1						3
	RO-IT		1		1		1				3
	SK-IT		1								1
Sheep < 6 Mo Total		3	9	4	4		3	3	2		28
Sheep > 6 Mo	ES-IT						1	1			2
	HU-IT			3		1		1	1		6
	RO-IT						3				3
Sheep > 6 Mo Total				3		1	4	2	1		11
Goats	NL-FR	2		1							3
Goats Total		2		1							3
Horses	BG-IT						1	2	2	2	7
	ES-IT				1						1
	FR-IT							1			1
	HU-IT			1	2		2		1	1	7
	PL-FR			1	1						2
	PL-IT	2	3	3	2	4	3	2	2	1	22
	RO-IT	2		1	3	3	3	1	1	1	15
	SI-IT	2	1								3
	SRB-IT								1	2	3
Horses Total		6	4	6	9	7	9	6	7	7	61
Other	UK-CH	1									1
Other Total		1									1
Grand Total		**67**	**58**	**67**	**76**	**53**	**76**	**56**	**49**	**13**	**515**

Table IV.2: Animal journeys recorded during February – October 2008 from the 21 participating vehicles, listed by country of origin and country of destination of the journeys recorded