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**ASSURANCE OF FARM ANIMAL WELFARE DURING  
TRANSPORT BY THE USE OF MODERN  
TECHNOLOGY**

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## Abstract

The European legislation regulates the transport of live animals strictly to ensure an adequate level of animal welfare. In this paper, the *guide to good practices for the transport of cattle* and additional literature was screened for options of technological nature which enhance animal welfare beyond legal minimum or facilitate the compliance with the legal minimum. Propositions to the authorized transporters, authorized keepers at check points and the competent authorities were formulated. It was concluded, that an improved temperature management, the reducing of the journey duration by optimized planning and the use of surveillance systems to monitor ABMs (Animal Based Measures) remotely can potentially enhance animal welfare during the process of transport. It was also concluded that the use of technology does not enhance animal welfare by default, as a multitude of factors have to be taken into account in that matter.

## Absztrakt

Az élő állatok szállítását az európai jogszabályok szigorúan szabályozzák az állatjólét megfelelő szintjének biztosítása érdekében. Ebben a szakdolgozatban a szarvasmarhák szállítására vonatkozó helyes gyakorlatokról szóló útmutatót és más kapcsolódó szakirodalmat vizsgáltuk meg az állatjólétnek a jogszabályi minimumon túli javítására, illetve az annak való megfelelés egyszerűsítésére irányuló technológiai lehetőségek szempontjából. Megfelelő javaslatokat fogalmaztak meg az engedélyezett fuvarozók, az ellenőrző vagy gyűjtőhelyek engedélyezett üzemeltetői és az illetékes hatóságok számára. Összefoglalva elmondható, hogy a szállítás alatti jobb hőmérséklet-szabályozás, a teljes szállítási idő optimalizált tervezéssel történő csökkentése, valamint az állatok különleges viselkedését és jóllétük további mutatóit (ABM-ek) nyomon követő rendszerek bevezetése potenciálisan elősegítheti az állatjóléti szabályoknak való megfelelést. Megállapítást nyert továbbá, hogy a technikai segédeszközök használata önmagában nem vezet automatikusan az állatok jólétének javulásához, mivel ebben az összefüggésben számos egyéb tényezőt is figyelembe kell venni.

## Abstrakt

Der Transport von lebendigen Tieren ist durch die europäische Gesetzgebung strikt reguliert, um ein adäquates Maß an Tierschutz (engl. animal welfare) zu gewährleisten. In dieser wissenschaftlichen Abschlussarbeit wurde der *guide to good practices for the transport of cattle* und weitere themenbezogene Literatur auf technologische Möglichkeiten geprüft, den Tierschutz über das gesetzliche Mindestmaß hinaus zu verbessern oder die Einhaltung des Selbigen zu vereinfachen.

Entsprechende Vorschläge für autorisierte Transporter, autorisierte Betreiber von Kontroll- oder Sammelstellen und zuständige Behörden wurden formuliert. Schlussfolgernd kann man verbessertes Temperaturmanagement während des Transports, eine Reduzierung der Gesamttransportzeit durch optimierte Planung und das Implementieren von Systemen zur Überwachung von spezifischen tierischen Verhaltensweisen und weiteren Indikatoren ihres Wohlbefindens (ABMs) als potentiell förderlich für die Einhaltung der Tierschutzverordnung bezeichnen. Weiterhin wurde festgestellt, dass der alleinige Einsatz von technischen Hilfsmitteln nicht automatisch eine Verbesserung des Tierschutzes (engl. animal welfare) nach sich zieht, da eine Vielzahl weiterer Faktoren in diesem Zusammenhang berücksichtigt werden müssen.

## Abbreviation

ABM: Animal Based Measures

°C: Degree Celsius

EFSA: European Food Safety Authority

EU: European Union

EC: Council regulation / comission regulation

h: Hour

km: Kilometre

KN: Kilo newton

lx: Lux

m<sup>2</sup>: Square meter

NGO: Non-governmental organization

No: Number

OIE: Office International des Epizooties

RFID: Radio-Frequency-Identification

TRACES: Trade control and expert system

UK: United Kingdom

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# 1. Introduction

The European Union's laws protect animals from unnecessary and disproportionate pain by default. Animal cruelty is a crime which can be punished with harsh fines or even time in jail.

The keeping, slaughter and also the transport of farm animals is regulated strictly in general within the borders of the European Union.

Nevertheless shocking headlines about terrible conditions in animal transportation can be found in the newspapers quite regularly. A lot of them are in connection with the export of cattle and sheep into third countries. NGOs document the problems occurring since the mid 90's.

The need for long distance transport of animals, especially into Muslim countries with warm climatic conditions, has increased in correlation with the growing market. To satisfy the consumer's needs in these specific regions, the cattle and sheep must be delivered alive, as the procedure of slaughter shall comply with the local religious believes and cultural traditions.

Unfortunately, the European regulations and ethics frequently collide with the procedures practised in these countries.

The court of justice of the European Union has ruled, that regulation EC 1/2005, which ensures animal welfare during transport, shall apply to all transported European animals from departure until the arrival of the place of destination, even if this place is located in a third country. A method to enforce this judgement is yet to be found. It's a problem of political nature and must be tackled as such.

The transport of animals presents a multitude of challenges of organizational, logistic and technological kind.

Animals are living creatures and therefore require very specific conditions to survive the journey unharmed. The margin of error during the process of transportation is extremely narrow and any mistake will cause suffering or even death of the animal. A steady supply of water and feed, as well as ventilation and temperature management are essential.

## Objectives

In this thesis, the regulation EC 1/2005 will be summarized and its working mechanisms will be analysed and listed. Furthermore the „guide to good practices for the transport of cattle“, part of a study commissioned and supported by the European Commission, and additional literature dealing with critical points of animal welfare during transport, is screened for propositions of technical nature to increase or to ensure animal welfare during the transport of cattle by road.

To increase or ensure the welfare, ways to optimize temperature management during transport, reduction of the journey's duration and surveillance of animal-based measures to monitor the animal welfare situation are assigned to the main protagonists of animal transport. Namely the competent authority, the transporter and the keepers at check points or assembly centres.

## 2. Literature review

### 2.1 Animal welfare

The OIE defines animal welfare as follows:

*„Animal welfare means how an animal is coping with the conditions in which it lives. An animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well nourished, safe, able to express innate behaviour, and if it is not suffering from unpleasant states such as pain, fear and distress. Good animal welfare requires disease prevention and veterinary treatment, appropriate shelter, management, nutrition, humane handling and humane slaughter/killing. Animal welfare refers to the state of the animal; the treatment that an animal receives is covered by terms such as animal care, animal husbandry, and humane treatment. “[1]*

Developed on the basis of the UK Animal welfare councils first guidelines, the „five freedoms“ explain how animal welfare can potentially achieved in an understandable manner. The five freedoms consist of:

- „(1) Freedom from thirst and hunger – by ready access to fresh water and a diet to maintain full health and vigour;*
- (2) Freedom from discomfort – by providing an appropriate environment including shelter and a comfortable resting area,*
- (3) Freedom from pain, injury and disease – by prevention or rapid diagnosis and treatment,*
- (4) Freedom to express normal behaviour – by providing sufficient space, proper facilities and company of the animal’s own kind.*
- (5) Freedom from fear and distress – by ensuring conditions and treatment which avoid mental suffering. “[1]*

The indicators of animal welfare can consist of a multitude of parameters and differ greatly in studies. The guide to good practices for the transport of cattle uses animal-based

measures (ABMs) to define the welfare of an animal. Examples for these measures are shivering, panting, lameness or cleanliness. [2]

Other scientific studies use blood parameters [3] or bodyweight gain [4] as indicators of animal welfare.

Due to the variety of parameters or measures proposed and the lack of existing benchmark values gathered under optimal animal welfare condition, it is hard to evaluate, which ABMs are favourable to use to actually indicate the level of animal welfare. [5]

## 2.2 Animal transport

From a practical perspective animal transport can be divided into 6 steps, as it is done in the consortium of the animal transport guides project.

*„Transport spans a chain of events from preparation to unloading. To facilitate the guide in every day practice, it will be structured according to six stages of the of the journey:*

- 1. Administrative issues*
- 2. Preparation and planning*
- 3. Handling and loading animals*
- 4. Travelling*
- 5. Stay at control posts, markets and assembly centres*
- 6. Unloading animals “[2]*

Furthermore, the duration/ distance, motivation (e.g. commercial reasons), and the vessel of transport need to be defined.

The duration of the journey will influence the measures that have to be taken to ensure the well-being of the transported animals, also the legal obligations will change accordingly. [2,6]

For comparison of the animal welfare situation, every step can be looked at separately. The administrative issues can be seen independently, as there must not be a connection in time or space to the other events.

## 2.3 Overview of EU legislation regarding animal transport

To ensure a high level of animal welfare for farm animals, all members of the European Union adopted a certain set of rules.

The council directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes, „...*lays down minimum standards for the protection of animals bred or kept for farming purposes.*“ [7] and council regulation (EC) No 1/2005 defines rules for animal protection during transport and related operations. [8]

The national law might be even stricter when it comes to animal protection and welfare. [8, Article 1, paragraph 3]

To understand how animal welfare during transport shall be guaranteed, it is necessary to have a look at EC No 1/2005 and conclude the mechanisms used. To do so, a short summary of the articles of interest is given.

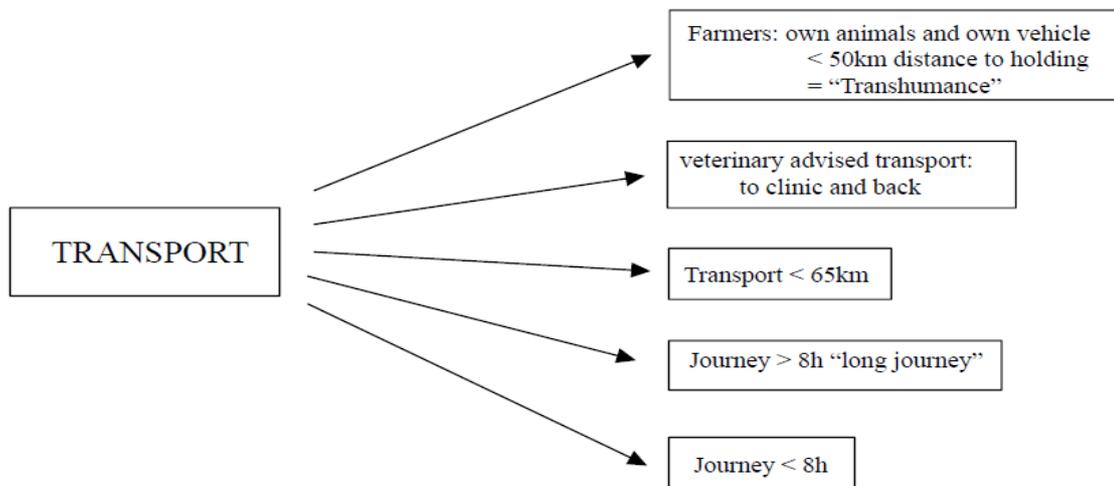
### 2.3.1 Basic terms and scopes

The scope of the regulation has to be defined, e.g. that the transported animals must be living vertebrae for this rule of the legislation to be applied. [8, Article 1]

Further the vocabulary used in the regulation needs explanation. Therefore, all important terms used are listed and a short definition is given. [8, Article 2]

General conditions to transport animals are mentioned. These include a set of principles, that should be followed at any time.

Injury or suffering should be highly unlikely during transport, the journey's duration should be kept as short as possible, only animals fit for the process of transportation should be loaded. Also, the transport vessels, loading and unloading facilities must be designed to ensure safety of the animals and be well maintained to limit risk of suffering or injury. The personnel shall be well trained in handling animals and check on the animal's welfare regularly. Sufficient room, water, feed and rest must be provided. [8, Article 3]



*Figure 1. Categories of animal transport procedures differentiated by European legislation [8, Article 1,10,11]*

### 2.3.2 Obligations of the transporter

#### Administrative obligations

Any transporter has the obligation to provide the travel documentation and animal identification to the competent authority. [8, Article 4]

Only authorized transporters shall be contracted and a natural person must be responsible to provide all informations regarding the transport if needed. No suffering shall be caused by insufficient planning. The weather is to be taken into account while planning. [8, Article 5]

Further responsibilities of the transporter include, that the transporter must be certified and authorized by the competent authority. Long journeys (over 8 hours of duration) must be authorized and only trained personnel shall handle the animals. Those must be transported in a safe manner and be provided with sufficient water, feed and rest. Persons transporting animals less than 65km from departure to the destination don't need to be certified. A specific navigation system must be used and the records be kept for 3 years to be checked by the competent authority. [8, Article 6]

The requirements for the transporter authorisation are as follows. Applicants must be established or represented in the member state, where they apply. Staff, equipment and

procedures must be demonstrated to be sufficient to comply with the regulation. The applicant cannot have a record of serious infringements of legislation on animal protection in the last three years before the application, or has to prove to the competent authority, that steps were taken to avoid infringements in the future. The authorisation given out by the competent authority is valid for maximum 5 years.

It's not valid for long journeys by default. [8, Article 10]

To get the authorisation for long journeys as a transporter, the applicant must comply with the statements mentioned and further the applicant must provide valid certificates for all drivers and attendants to be qualified for long journey transportation. Also, the means of transportation need to be validated and certificated for use in long journey transportation. The road vehicles must be traceable and their movement must be recorded. There must be a procedure to contact the driver anytime during a long journey. Plans for emergency situations must be provided. The transporters for long journeys must be equipped with a specific navigation system. The authorisation given out by the competent authority is valid for maximum 5 years. [8, Article 11]

Transporters shall only apply to only one competent authority in only one member state to get the authorisation to transport animals. [8, Article 12]

Road drivers and attendants for the specified animal transports must be trained in the technical and administrative aspects of EC 1/2005 with special attention to the general conditions of animal transport [8, Article 3] and the obligation to provide proper travel documents and animal identification [8, Article 4], as well as animal physiology, handling of animals, driving behaviour and its impact on the animal or meat quality, emergency care for animals and „*safety considerations for personnel handling animals*“.

The road drivers and attendants must have passed an examination regarding the named topics. The examiner shall be independent and the exam must be approved by the competent authority. [8, Annex IV, 1.-2.]

1. TRANSPORTER AUTHORISATION No		
2. TRANSPORTER IDENTIFICATION		<b>TYPE 1</b> <b>NOT VALID</b> <b>FOR LONG JOURNEYS</b>
2.1. Company name		
2.2. Address		
2.3. Town	2.4. Postal code	2.5. Member State
2.6. Telephone	2.7. Fax	2.8. Email
3. AUTHORISATION LIMITED TO CERTAIN		
Types of animals <input type="checkbox"/>		Modes of transport <input type="checkbox"/>
Specify here:		
Expiry date.....		
4. AUTHORITY ISSUING THE AUTHORISATION		
4.1. Name and address of the authority		
4.2. Telephone	4.3. Fax	4.4. Email
4.5. Date	4.6. Place	4.7. Official stamp
4.8. Name and signature of the official		

*Figure 2. Transporter authorisation issued by the competent authority in accordance to EC 1/2005*

### Journey log

The EC 1/2005 contains all details regarding the journey log and the standardized forms of the journey log. [8, Annex II]

It is stated, that for the preparation of a long journey, all pages of the journey log need to be filled in, stamped and signed.

The journey log must consist of 5 sections, in this order: Planning, place of departure, place of destination, declaration by transporter, specimen anomaly report. [8, Annex II, 1.-2.]

1. <b>DECLARANT'S</b> name, title and address	
2. Place and Member State where the anomaly was observed	3. Date and time when the anomaly was observed
4. <b>TYPE OF ANOMALY(IES)</b> pursuant to Council Regulation (EC) No 1/2005	
4.1. Fitness for transport <sup>(1)</sup> <input type="checkbox"/>	4.6. Space allowances <sup>(4)</sup> <input type="checkbox"/>
4.2. Means of transport <sup>(2)</sup> <input type="checkbox"/>	4.7. Transporter's authorisation <sup>(7)</sup> <input type="checkbox"/>
4.3. Transport practices <sup>(3)</sup> <input type="checkbox"/>	4.8. Driver certificate of competence <sup>(8)</sup> <input type="checkbox"/>
4.4. Journey time limits <sup>(4)</sup> <input type="checkbox"/>	4.9. Journey log records <input type="checkbox"/>
4.5. Additional provisions for long journeys <sup>(5)</sup> <input type="checkbox"/>	4.10. Other <input type="checkbox"/>
4.11. Remarks:	
5. I hereby declare that I have checked the consignment of the abovementioned animals and have expressed the reservations detailed in this report concerning compliance with the provisions of Council Regulation (EC) No 1/2005 on the protection of animals during transport and related operations.	
6. Date and time of the declaration to competent authority	7. Signature of the declarant

Figure 3. The fifth sections of the journey log in accordance to EC 1/2005. The "specimen anomaly report".

The organizer is obligated to keep every journey log identifiable by numbering it and provide a signed and filled in copy of the planning section to the competent authority of the place of departure, at least two working days before the journey. Furthermore, the organizer must comply with the competent authority's instruction and make sure that the journey log is stamped correctly. Also, the journey log must stay with the animals from departure to place of destination or at least to the exit point, if the animals are exported to a third country. [8, Annex II, 3.]

Once the journey is completed within the community's territory, the transporter must sign the completed declaration by transporter. [8, Annex II, 5.- 6]

The transporter shall keep a copy of the completed journey log and the corresponding record sheet produced by the transportation recording equipment, if the means of transportation is required to have one.

Those document must be available to the competent authority that granted the authorisation of the transporter and the competent authority of the place of departure, The documents must be available to them within 1 month after the journey was completed. The transporter

shall keep the document for minimum 3 years, counting from the date they were checked. The journey log had to be returned to the competent authority of the place of departure, if no specific navigation system was used. This system is mandatory nowadays. [8, Annex II, 8.]

### General obligations

It's the transporter's obligation to make sure, that all animals transported are indeed fit for transport. In the legislation the animal's physical condition, which deems it fit or unfit for transport, is defined.

Animals, that would suffer unnecessarily due to the process of transportation, shall not be transported. Conditions that do not allow the transport, are being unable to walk unassisted or only with great pain, prolapse or severe wounds. Also, females who gave birth in the last week or females who are in the time frame of the last 10% of the gestation period shall not be transported.

New-borns cannot be transported, until the navel is completely healed. Calves younger than ten days of age shall only be transported a distance of less than 100km. Cervidae in velvet are not allowed to be transported. [8, Annex I, chapter 1, paragraph 1.- 2.]

There are exceptions for the transportation of animals deemed unfit for transport.

Slightly sick or injured animals can be transported, if the process doesn't cause additional suffering. A veterinarian can be consulted to confirm.

If the injury or sickness is part of a legal research, the animals may be transported. Also, injured or sick animals may be transported for veterinary diagnosis or treatment and under supervision of a veterinarian. The process shouldn't cause additional suffering.

Animals injured by performing farming procedures e.g. dehorning by a veterinarian, can be transported, once the wounds have healed completely. [8, Annex I, chapter 1, paragraph 3.]

If animals fall sick or are injured during transport, they must be separated. They must receive first aid treatment and veterinary treatment as quick as possible. Humane emergency slaughter or humane killing must be performed to limit suffering, if needed. [8, Annex I, chapter 1, paragraph 4.]

Sedatives shall only be used on transported animals under veterinary supervision and only if absolutely necessary to guarantee animal welfare. [8, Annex I, chapter 1, paragraph 5. ]

If lactating bovines are transported without their offspring, they must be milked at least every 12 hours. [8, Annex I, chapter 1, paragraph 6.]

### Handling and transport practices

Transport practices, including the loading, unloading, the facilities for loading and unloading and the handling of the animals are specified.

Generally, it should be kept in mind that animals might need some time to acclimate to a mode of transport, before the process of transportation starts. [8, Annex I, chapter 3, paragraph 1.1.]

If in addition to animals, other goods are transported, it must happen in a way, that the animals can't be injured, caused to suffer or be distressed by the other goods. [8, Annex I, chapter 3, paragraph 1.5.] During the process of loading or unloading, sufficient lightning is required [8, Annex I, chapter 3, paragraph 1.6.]

Avoid the leakage of urine and faeces, ensure the stability and ensure the unimpaired airflow, if containers with animals inside are stacked on top of each other. [8, Annex I, chapter 3, paragraph 1.7.]

The handling of the animals is subject to a set of rules. Actions taken, tools and equipment used and special precautions for tying animals are regulated.

It's prohibited to strike and kick the animals, apply pressure or handle them in a way to cause unnecessary pain and suffering, Also lifting and dragging animals by „*head, ears, horns, legs, tails or fleece*“ is prohibited.

Animals shall not be suspended by mechanical equipment themselves. Also, equipment with pointy ends shall not be used on animals and intentional blocking of an animal, that is led through the facility is prohibited. [8, Annex I, chapter 3, paragraph 1.8.]

The use of electro-shockers is to be avoided. If absolutely necessary they can be used on the muscles of the hindquarters of adult cattle or pigs, but the way in front of the animal needs to be clear and the shock must last less than a second. Repetitive shocks shall not be inflicted, even if there is no response. [8, Annex I, chapter 3, paragraph 1.9.]

Tying animals by the horns, nose ring or feet and muzzling calves is forbidden. Equipment used for tying animals must be rigid enough not to break during regular transport. A tied animal must be able to eat, drink and lie down if necessary. The equipment must allow the

animal to be released quickly and not pose as a danger of strangulation or injury. [8, Annex I, chapter 3, paragraph 1.11. ]

The separation of animals during handling and transport is also to be addressed.

Animals of different species, age or size should be separated for handling and transport.

Same goes for sexually mature animals of male and female sex, horned and dehorned animals, tied and untied animals. Animals showing hostile behaviour towards each other must be separated as well. [8, Annex I, chapter 3, paragraph 1.12.]

The exceptions to this rule would be, that a compatible group of animals or a group raised together is not to be separated because it would cause unnecessary distress. Also, dependent youngs should not be separated from the mother. [8, Annex I, chapter 3, paragraph 1.13.]

The practices during transport, ruled in the regulation, include minimum space allowances. [8, Annex I, chapter 3, paragraph 2.1.]

They may vary due to the animal's species, size, weight, physical condition, as well as the duration of the journey and the weather conditions.

To determine the area that needs to be provided in case of cattle, the animals are categorised based on their weight. Six categories need to be differentiated. The following values are valid for transport by road.

Small calves, approx. 50 kg, need to be provided with 0,3-0,4 m<sup>2</sup> per animal.

Medium sized calves, approx. 110 kg, need to be provided with 0,4-0,7 m<sup>2</sup> per animal.

Heavy calves, approx. 200 kg, need to be provided with 0,7-0,95 m<sup>2</sup> per animal.

Medium sized cattle, approx. 325 kg, need to be provided with 0,95-1,3 m<sup>2</sup> per animal.

Heavy cattle, approx. 550 kg, need to be provided with 1,3-1,6 m<sup>2</sup> per animal.

Very heavy cattle, approx. >700 kg, need to be provided with >1,6 m<sup>2</sup> per animal.

*„These figures may vary, depending not only on the animals' weight and size but also on their physical condition, the meteorological conditions and the likely journey time.“* [8, Annex I, chapter 7, B.]

Sufficient ventilation, dependent on number and species of the animals and the climate conditions during the journey, must be ensured. [8, Annex I, chapter 3, paragraph 2.6.]

During transport, sufficient water, feed and rest should be offered in intervals according to the age and species of animals. Detailed information about each species-specific set of

rules if found in chapter 5 of the annex I. If not stated otherwise, mammals must be at least fed every 24 hours and watered every 12 hours. The quality of water and feed must be good and the animals shall be accustomed to the way of intake. [8, Annex I, chapter 3, paragraph 2.7.]

Watering and feeding intervals, journey times and resting periods of the different species are strictly regulated for transports. All necessary information concerning cattle and calves are to be found below.

Only calves older than 14 days or being accompanied by their mother are allowed to be transported on long journeys (> 8h). [8, Annex I, chapter 6, paragraph 1.9.]

Unweaned calves on milk diet may be transported for 9 hours, before given a period of at least one hour to rest, be fed liquid and if necessary be offered additional feed. After this period, they can be transported for another 9 hours. [8, Annex I, chapter 5, paragraph 1.4. (a)]

Domestic bovines can be transported for 14 hours, Then, they must be given a period of at least one hour to rest and be provided with liquid and be fed if needed. After this period, they can be transported for another 14 hours. [8, Annex I, chapter 5, paragraph 1.4. (d)]

Once the journey time is over, the animals shall be unloaded to rest for at least 24 hours. They must be fed and watered also. [8, Annex I, chapter 5, paragraph 1.5.]

The journey times can be extended for up to 2 hours in the interest of the animals transported, if the destination is at reasonable proximity. [8, Annex I, chapter 5, paragraph 1.8.]

Member states are authorised to allow animals to be transported for maximum 8 hours to be slaughtered in the place of destination. The journey time cannot be extended and the place of departure, as well as the place of destination must be located in the member state's own territory. [8, Annex I, chapter 5, paragraph 1.9.]

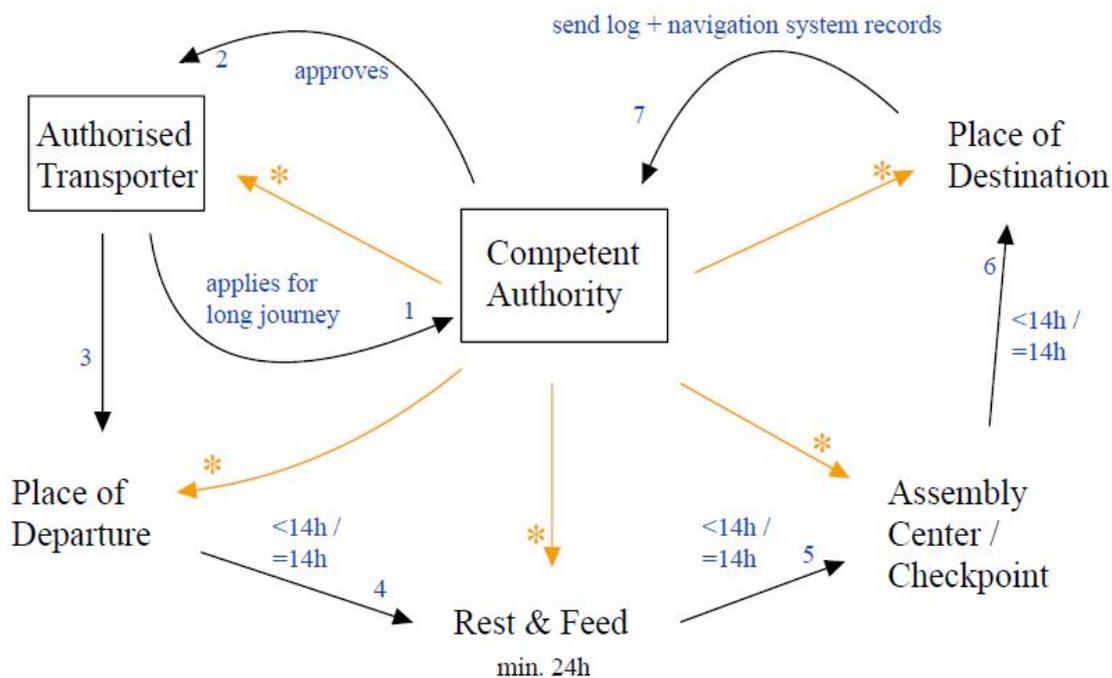


Figure 4. The phases of an exemplary long journey of adult cattle transported by road vehicle. The orange markings represent potential random or targeted checks by the competent authority [2]

### 2.3.3 Rules applied to the means of transport

The means of transport are subject to the prior checking and approval by the competent authority. [8, Article 7]

In the legislation, the characteristics required by the regulation for all means of transport and containers used, are listed. Some additional provisions are defined for different types vehicles, vessels and planes. Only the general characteristics and the ones that have to be taken into account for road going vehicles are listed below.

All means of transport and containers must have such characteristics, that they ensure animal safety and avoid injury or suffering, protect animals from the weather conditions sufficiently, can be cleaned and disinfected, are rigid enough to prevent the animals from escaping or falling out by accident, assure appropriate air quality and quantity, allow access to the animals for inspection or care and a light condition allowing to do so, provide

a floor that prevents slipping and leakage of faeces and urine. [8, Annex I, chapter 2, paragraph 1.1.]

The space in all of the animal compartments must be adequate to allow sufficient airflow, even when the animal is in standing position without obstructing the natural movement. [8, Annex I, chapter 2, paragraph 1.2.]

The stability of the partitions must be sufficient to resist the animal's weight and quickly operable fittings must be used. [8, Annex I, chapter 2, paragraph 1.4.]

Calves younger than 6 months of age must be provided with bedding material to ensure comfort. The amount of animals transported, duration of journey, climate conditions and capability of the material to absorb faeces and urine must be taken into account. [8, Annex I, chapter 2, paragraph 1.5.]

There are some specific provisions for transport by road. The vehicles used in transport of animals must be clearly marked to signal the presence of live animals. Also, the vehicles must be equipped with the means necessary for loading and unloading of the animals. [8, Annex I, chapter 2, paragraph 2.1., 2.2.] If the vehicle transporting animals should be transported by vessel, it must be equipped with adequate securing points to fix its position on the vessel. [8, Annex I, chapter 2, paragraph 3.2.]

The maximum journey time for domestic bovines is 8 hours, but can be extended if specific measures are taken. [8, Annex I, chapter 5, paragraph 1.1.-1.3.]

These measures regarding the means of transport include the required navigation system, age of the transported animals, water and feed supply during the journey and ventilation for long journeys. [8, Annex I, chapter 6]

It is stated, that the vehicle must be equipped sufficient insulation and with a roof of light color. The animals must be provided with bedding that guarantees comfort. The bedding must be chosen in accordance with the species, number of animals, duration of journey and weather conditions. It must also be able to absorb urine and faeces sufficiently. [8, Annex I, chapter 6, paragraph 1.1.-1.2.]

A sufficient amount of feedstuffs for the duration of the journey and the necessary feeding equipment must be carried by the means of transport. The feedstuffs must be protected from weather conditions and contamination. When the specified feeding equipment is not in use, it shall be stored safely and separated from the animals. [8, Annex I, chapter 6, paragraph 1.3.-1.5.]

Adjustable partitions must be installed on the means of transport and be able to create

compartments adapted to the requirements specified by the amount and size of the species transported, while allowing all animals access to water. [8, Annex I, chapter 6, paragraph 1.7.-1.8.]

The means of transport must be equipped with such a water supply system, that the attendant can provide water to the animals in an instant if needed during the journey. All animals must have access. The watering system must be working and correctly positioned to allow the animals to be watered on board.

The minimum capacity of the water tanks is set to be 1,5% of the maximum payload of the means of transport. The design of the water tanks must allow draining and cleaning after every journey. The water level must be displayed and the tanks must connect to the drinkers in each compartment. They are to be maintained in order to keep them in a working order. [8, Annex I, chapter 6, paragraph 2.1.- 2.3.]

For transportation by road, the ventilation system must keep the temperature within the means of transport, moving or stationary, in between 5°C and 30°C for all animals during the journey. There is a tolerance of 5°C.

The ventilation system must work independently for at least 4 hours and provide a minimum nominal airflow of 60m<sup>3</sup>/h/KN of payload.

The means of transport needs to be equipped with a temperature monitoring system. The sensors must be installed in the area of the lorry expected to have the worst climatic condition. The system must record the temperature and the records need to be dated and upon request provided to the competent authority.

If the temperature in a compartment reaches the set minimum or maximum, a warning system must be triggered to inform the driver. [8, Annex I, chapter 6, paragraph 3.1-3.4.]

Means of transport intended to be used for transportation on road must be equipped with a navigation system. The system must record specific information regarding the course of the journey, resting times and places, stops and their duration for other reasons. Also opening or closing of the loading flap shall be recorded by the system. [8, Annex I, chapter 6, paragraph 4.1.]

### 2.3.4 Obligations of keepers and assembly centers

Keepers at departure, places of transfer or destination are advised to keep the rules of the legislation and check for animals which were subject to a long journey. It must be made sure, that those animals are treated accordingly, e.g. get time to feed or stay resting for 24 hours. [8, Article 8]

Also it is made sure, that animals are treated lawfully in the assembly centers. The operators must be approved and only let trained personnel handle the animals. The personnel shall be reminded of their duties regularly and of the consequences of infringement, as well as which competent authority can be notified in case of an infringement. The operator of the center must enforce and monitor the obligations of the personnel, set by the regulation. Internal rules shall be set if necessary. [8, Article 9]

If the loading or the unloading takes more than four hours, the animals must be provided water and feed in an appropriate facility outside of the means of transportation, while being untied and an authorised veterinarian shall supervise the process. Animal welfare shall be ensured by taking special precautions. This paragraph doesn't apply to poultry. [8, Annex I, chapter 3, paragraph 1.2]

When it comes to the facilities used for loading or unloading, their characteristics should ensure safety of the animals and minimise the chance of injury, distress and excitement. The floor should provide decent grip to the animals to reduce slipping and potentially injuries. The facilities must prevent escape of animals. Cleaning and disinfecting the facility must be possible. [8, Annex I, chapter 3, paragraph 1.3.]

There is a technical set of rules concerning the ramps and lifting platforms. Ramps used by calves shall only be as steep as 20 degrees, Ramps used by cattle other than calves shall only be as steep as 26 degrees 34 minutes. A system that ensures animals can climb up or down without risks or difficulties, as „*foot battens*“ should be installed on ramps steeper than 10 degrees.

Lifting platforms, as well as upper floors, are required to be equipped safety barriers. [8, Annex I, chapter 3, paragraph 1.4.]

Animals not used to be tied shall not be tethered. The facility should be able to provide equipment for tethering, if needed. Still the access to water is obligatory. [8, Annex I, chapter 3, paragraph 1.10.]

Regarding the journey log, keepers at the place of departure and at the place of destination (if located in the community) are required to fill in the according section of the journey log. The form found in section 5 shall be used to inform the competent authority about reservation that are questionable regarding the compliance with regulation EC 1/2005. [8, Annex II, 4.]

Keepers at the place of destination are required to keep the journey log (excluding the declaration by transporter) for at least 3 years from arrival, if the destination is located in the community, and make it available to the competent authority upon request.

Once the journey is completed within the community's territory, the transporter must sign the completed declaration by transporter. [8, Annex II, 5.- 6.]

### 2.3.5 Obligations of the competent authority

The competent authority can take precautions in connection with issues of transport/ long journey authorisations. The scope of authorisation may be limited. Each authorisation of transport has to be marked with a unique number and the certificate of authorisation needs to be provided in the member state's language as well as in English, if the transporter may operate in multiple states. Each transport authorisation has to be recorded in such a way, that the competent authority can identify the transporter quickly. It's important for infringement of the regulation. All long journey authorisations issued have to be recorded in an electronic database, including name and authorisation number of the transporter.

Name and number are to be made accessible to the public. [8, Article 13]

Specific checks need to be done by the competent authority concerning the journey log before a long journey. In case of long journeys between member states or third countries, the competent authority located at the place of departure should check to validate the transporters authorisation, certificate for long journeys, certificate of the drivers/ attendants, the prepared journey log to be realistic. Now the journey can be approved or the organizer of said journey can be advised to change arrangements before approval. If approved, the journey log is stamped and send to the competent authority of the destination. [8, Article 14]

Checks at any point of the long journey, done by the competent authority, are described in the legislation. Random or targeted checks can be done at any point to verify the journey times and the compliance of driving and resting times. The fitness check of the transported animals should be carried out before the loading in case of a long journey between member states and third countries. If the destination should be a slaughterhouse, the regulations of animal welfare set by the EU must be adopted in the slaughterhouse. The records of the navigation system can be used to do checks, if appropriate. [8, Article 15]

Working staff of the competent authority shall be trained and equipped to check the recording equipment for the road transport and the navigation system. [8, Article 16]

Trainings and the certificates for the personnel of transporters as well as assembly centers are specified in the legislation. First of all, training should be available. The certificate, issued by the competent authority, shall be available in the official languages of the member state and also in English, if operation in other member states is likely. The scope of the certificate can be limited to one or multiple species. [8, Article 17]

When it comes to the certification of the means of transport by road, the means of transport can only apply for certification in one member state and cannot apply or be approved in multiple member states at the same time. The means of transport need to be inspected by the competent authority and design, maintenance and construction must comply to the regulation regarding long journeys by road. Each certificate issued must have a unique number and be issued in the official languages of the member state and in English. It is valid for maximum 5 years and modification of the means of transport make it invalid. Approved certificates need to be put on an electronic database to ensure easy identification by all member states. Member states can grant derogations, if the transport does not take longer than 12 hours from departure to the final destination. [8, Article 18]

Border exit and border inspection points are used for the monitoring of animal transport. At these points, an official veterinarian shall check the authorisation and certification of the vehicle and driver, the fitness of the transported animals for further transportation and that the journey to the place of first unloading in the country of final destination complies with the regulation.

Also, it needs to be assessed if the animals are to be or have been already transported on a long journey. In case a long journey, the checks need to be recorded and the records kept in storage by the competent authority for 3 years at least. If the animals are deemed unfit for

further transport, they must be unloaded, be fed and watered and rested. [8, Article 21]

In case of export to third countries the official veterinarian shall receive the journey log at the point of exit. If live cattle are exported with refunds, the third section of the journey log might not be needed, if the legislation of agriculture requires a report. [8, Annex II, 7.]

Any delay during transport shall be minimized and competent authorities shall ensure that arrangements are made to do so. A consignment of animals shall only be detained if absolutely necessary and if the detainment takes longer than 2 hours, arrangements for the care of the animals shall be made, including feeding, watering, accommodation. [8, Article 22]

Emergency measures must be put into force if transporters do not comply with the regulation. If there is no compliance to the regulation, the competent authority has to take any action, that is sufficient to ensure the welfare of the animals in concern, without causing further suffering. The cost of actions shall be recovered accordingly.

Examples for the actions mentioned can be to replace the driver, repair the means of transport or replace it, unload the animals at a chosen holding to ensure animal welfare. If animal welfare can't be safeguarded, euthanising the animals in a humane way. If the person, responsible to carry out the instructions, can't be contacted or is unable to carry them out, the competent authority must take action itself. [8, Article 23]

Actions need to be taken in case of infringement and the notification of such. If an infringement is observed, the competent authority shall take action and notify the competent authority, which certified or authorized the transport. If the competent authority of the final destination observes an infringement, that happened during the journey, the competent authority of the place of departure must be informed without delay. If a transporter or the means of transportation don't comply with the regulation or the competent authority is notified about a non-compliance, the competent authority shall advise the transporter to clear the issue and find a way to prevent the recurrence, order additional checks by a veterinarian during loading, suspend the authorisation of the transporter or withdraw the certificate of approval of the means of transport in question. If a certified driver or certified attendant doesn't comply with the regulation, under specific conditions (e.g. lack of knowledge or awareness), the certificate can be suspended by the competent authority. A member state can prohibit the transportation of animals by a

transporter who committed serious or repetitive infringements temporary, even though the transporter might be authorised by a different member state. Member states shall share information concerning the decision of withdrawal or suspension of authorisations or certifications immediately. [8, Article 26]

Furthermore, the competent authorities shall do inspections of the animals, means of transport and required documents to confirm the compliance of the regulation. The amount of inspections depends on the number of animals transported and the amount of times the regulation wasn't complied with. Also, every year, the member states must hand in a report to the commission in which the inspections, major issues within them and potential solutions are the topics. [8, Article 27]

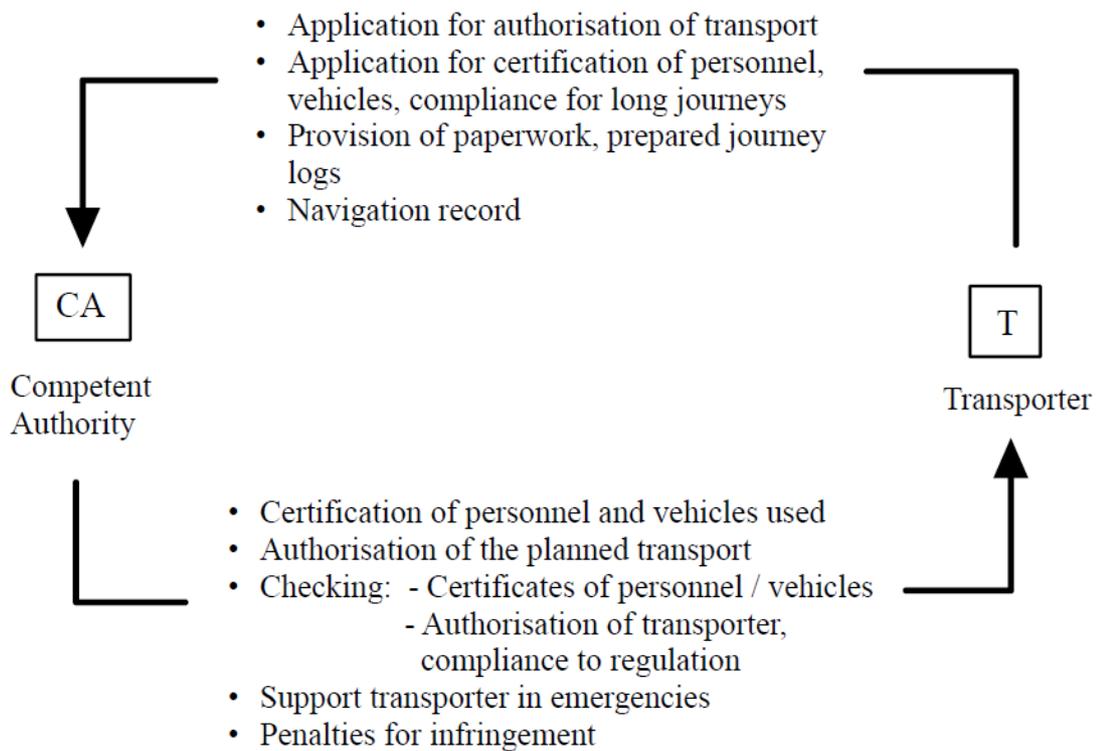


Figure 5. Relations between the competent authority and the authorized transporter regarding animal transport in accordance to EC 1/2005

### 2.3.6 Obligations of the member states

The legislation advises the mutual assistance and the exchange of informations between the member states. [8, Article 24]

Also it obligates the member states to decide upon a set of penalties for the infringement of the regulation. [8, Article 25]

It is declared, that the commission may send veterinary experts to do „*on-the-spot-checks*“ to confirm conformity with the regulation in agreement with the competent authority of a member state. [8, Article 28]

Further it is advised to the member states to support and encourage the development of guides on how to comply with the regulation on a national or community level. These guides are referred to as „*guides to good practice*“. [8, Article 29]

## 2.4 Synopsis of the technical aspects of the guide to good practices for the transport of cattle

### 2.4.1 General information

The suggestions from the guide to good practices regarding the use of modern equipment or the modification of equipment mentioned in the EC regulation 1/2005 are listed. These suggestions might specify the abilities and characteristics of said equipment, that must be given, to improve the animal welfare or give general advise for the use of existing systems, equipment or tools.

The guide is not legally binding. Its sole purpose is to make it more obtainable to comply with the given regulation and to improve animal welfare beyond the legal minimal requirements. [2]

Animal based measures („ABMs“) are used to monitor the current state of animal welfare. They have to be interpreted with knowledge of their meaning and consequences, professional knowledge is an advantage.

ABMs that can be monitored easily, are of visual nature. Shivering or panting indicates thermal discomfort, falling or lameness indicates disorientation or pain.

The drivers, keepers or personnel of the competent authority can get a first impression on the state of welfare by view. If ABMs are combined with the reading of sensors onboard of the transport vehicle, like the temperature, a well-trained person is able to evaluate the

animal welfare situation more precisely. [2]

Just because an animal can be transported legally, doesn't mean it will undergo the process unharmed and in in a good state of welfare. [9]

#### 2.4.2 Administration

The guide proposes to use the „Trade control and expert system “TRACES, for real time transmission of legally required and additional information regarding the journey.

These informations can consist of date and time of loading the first and unloading the last animal for precise evaluation of the duration of the journey, a list of the animals specifying the number and species, as well as losses or injuries occurring during the journey.

Further information can be the time/date of coupling or decoupling trailers and details regarding their attached equipment. Total weight of the animals transported (or an estimate) and the place, time and date of transfers or resting breaks can be given as well.

[2]

To ensure the adequate competence of the personnel, it is suggested to check and record the abilities and skills of the transporter. Audits and random checks could be an option. Continuous training shall be provided. [2]

#### 2.4.3 Preparation and planning

The planning of a journey could be simplified by using a commercial software, that takes all relevant terms regarding the regulation into account, including journey and resting times, other scheduled stops, the weather forecast, driver hours, traffic reports or the predicted workload and therefore waiting times at control posts.

The optimized planning should improve animal welfare, as chances of unforeseen prolonged duration of the transport is minimized [2]. Keeping the journey as short as possible corresponds with the regulation EC 1/2005 [8, Article 3] and is believed to be beneficial influence on the transported animals. [4]

It is proven, that the transport distance can be reduced by the use of algorithm for weaned calves going from the calf production facilities to the fattening facilities in France. [10]

The importance of effective communication is also highlighted, especially between transporter and loading/unloading locations. Electronic communication or contact by

phone is essential for the journey to go smoothly. [2]

Preparation all the required paperwork should be done in advance, if possible at least „*in a timely manner*“. That should help to shorten the time between the end of loading the animals onto the truck/trailer and effectively starting the journey. [2]

When it comes to setting up contingency plans, keeping in mind the energy supplies for all technical systems installed in the vehicle is essential. In case of an emergency, like the breakdown of the vehicle, it is advised to have an emergency generator installed to ensure sufficient ventilation. That's even more important when transporting unweaned calves. [2]

A week before the transport, it is advisable to collect all necessary data about the animals transported, including a list of animals with little injuries or animals required to be treated in a special way and forward said information to the transporter.

Adjustable loading ramps, which allow animals to be loaded or unloaded in a safe manner, should be provided at the place of departure, check points and place of destination. [2]

The importance to keep animals dry during loading should be kept in mind, when the loading area is designed and constructed. If necessary, temporary modifications of the area shall be made to protect the animals from the weather. A dry coat is essential to resist cold climate and decreases contamination of the vehicle. [2]

## 2.4.4 Travel and the means of transport

### Temperature management

The thermal environment is extremely important when it comes to animal welfare during transport. The vehicle should be well equipped to not only ensure the compliance with the legal requirements, but to keep temperature as close to the thermal optimum as possible. [2]

The thermal condition has an influence on physiological functions of the animal as well as the production capacity. [11]

A proper ventilation system will reduce the thermal stress of the animals greatly and has a positive influence on animal welfare,

When transporting animals from the northern part of Europe to the southern parts, the

management of thermal stress becomes even more important with the rise in temperature. Forced ventilation is obligatory for long journeys, but recommended by the guide for regular journeys also, for better management of the thermal condition inside the vehicle. If the truck is fully air conditioned, the system should be able to run for at least 4 hours at temperatures over 30°C, even when the truck is at still stand. [2]

### Climate control

*„The internal thermal micro-environment on vehicles is a major determinant of animal welfare and may pose a significant hazard in terms risk of heat or cold stress.“*

Humidity influences the impact of the temperature on the animals' physiological state and animal welfare. With increasing humidity, the even lower temperatures can pose a threat to the animal's well-being. [2]

One reason is, that increased air humidity impacts the heat loss by evaporation of the animal. [12]

Lactating cows are more susceptible to low or high temperatures. Between 5°C and 15°C, the temperature is acceptable. Below this range, the cow mobilises additional energy resources to keep the body temperature at level, above the range, at 21°C, signs of heat stress can show.

In lactating cows, the production level is influenced, among other factors, by heat stress. It might influence production negatively. [13]

*„Key to assessing the risk of thermal stress is monitoring the internal thermal environment on vehicles and the risk of thermal stress can be managed by appropriate ventilation systems, regimes and volume flow rates.“* [2]

The guide assesses mechanical (active) ventilation to be beneficial in any case, but even with a very controllable airflow within the vehicle, parking in the shades and at a 90° angle to the direction of wind is advised.

Behaviour and distribution of the animals must be monitored to check, if the ventilation is sufficient or signs of heat stress or exposure to noxious gases can be noted. It is preferable to keep temperatures during transport between 5°C and 30°C for non-lactating cattle and not to get close to the limits set in the regulation 1/2005. [2]

If the weather conditions might cause the animals to be cold, there are multiple options to act upon it. Space allowance can be reduced and extra bedding can be provided. The vehicle can be adjusted to provide more protection from the weather by closing flaps on the lateral sides. Heating up the inside of the vehicle before loading can help to prevent hypothermia, especially when calves are transported. Measures to prevent freezing of the drinkers must be taken also. [2]

In warm weather conditions it is advised to increase the space allowance, but consider the increased risk of falls and injury at the same time. It should be checked on the animals as often as possible for signs of heat stress and the provision of water must work flawlessly. [2]

The respiratory frequency of cattle increases visibly at temperatures from 25°C and above. [14]

The increase of airflow is recommended. Alternatively, vehicles equipped with a climate control system can be used or the journey can be delayed into the night for lower temperatures. [2]

### Space management

Just as important is the space allowance. The animal welfare can be negatively influenced by inadequate space allowance, e.g. limits the accessibility of the drinkers. [2]

Serious overcrowding with loading densities beyond the legal limit can endanger the lives of transported animals. [15]

Too much space can induce falls and bruises. The height above the head must be limited to prevent mounting behaviour, but sufficient to allow airflow.

An anti-slip coating of the floor and well-maintained suspension reduce muscular fatigue, as the animal doesn't have to work hard to stay in a stable position.

The range for space allowances in the regulation EC 1/2005 is based on the following equation:

$$A (m^2) = 0.021 * W^{0.67}$$

*A = space per head*

*W = body weight [2]*

It can be discussed, if the use of an equation is adequate to define the optimal space allowance for animal transport. [16]

To achieve a suitable pen size, the partitions must be in placed correctly. As the width of the trailer/truck is given, only the length of the pen can be managed freely in most cases. Calculating the optimal setup and placing the partitions accordingly is necessary. Also make sure, that there is little to no gaps between the floor, wall and the partition to reduce the chance of injury.

Partition should be designed to be adjustable as easy and flexible as possible, so does the head space. Increasing the head space for airflow, and penning animals only in the cooler parts of the vehicle, can be effective tools to combat heat stress in a warm environment. In this case, anti-mounting racks should be installed for transportation of bulls. [2]

### Bedding

Bedding materials are only mandatory for calves of a certain age, but can make a big difference for adult cattle to. Sufficient bedding will help the animals to find some rest during the transport and improve animal welfare therefore.

The guide recommends at least 10kg straw/m<sup>2</sup> or (in warm conditions) 8-10kg/m<sup>2</sup> of crushed straw pellets. [2]

### Additional sensors and surveillance

The guide recommend to use a truck or trailer for animal transport, which allows to inspect the animals from the outside or via a camera system at all times.

Further, additional parameters, besides the temperature of the compartments should be monitored and recorded. Vibration, total weight of the animals and relative humidity could be monitored for example. The sensors used must be robust and deliver information reliably in all expected conditions. [2]

The development and testing of remote measurements of stress and therefore the level of welfare during transport is of importance. For example, the use of algorithms to analyse video material taken by a camera inside the vehicle to detect signs of pain or characteristic postures should be considered. [17]

Also an automatic system that controls the forced ventilation system based on the parameters read by the sensors, would be a useful addition. [2]

The regulation EC 1/2005 states that two temperature sensors per level/deck must be installed in the area of the vehicle, that is expected to have the worst environmental condition. [8,Annex I, chapter 6, paragraph 3.1-3.4.]

In the guide, better practices are listed, such as the installation of additional sensors (four/deck), using sensors with additional functions to collect more diverse data, implementing a system that records the readings and provides the collected information in a digital form or as a printout and is capable to exclude readings from unused areas or pens of the vehicle, which would distort the interpretation of the collected data. [2]

### Feed & Water

An adequate access to water and feed is connected to an increase in comfort when analysing animal behaviour. [18]

Sufficient amounts of feed must be available for the journey, potentially spare capacity for transport of the feed and animals on the same vehicle shall be ensured. Providing the specific feed, that the animals are used to, will enhance animal welfare and is recommended. [2]

The water supply system shall be designed and installed in such a way, that every pen can be provided with two drinkers, leakage and spilling is avoided, maintenance, inspection and cleaning is effective and can be done regularly and the water capacity is sufficient for the journeys the vehicle is used for. It is important, that cattle and calves are used to the type of drinker installed and use them accordingly.

A monitoring and adjusting system for the flow rates of the drinkers is recommended. The quality of the drinking water provided must be good. Changes in quality can cause animals to refuse drinking, develop digestive problems or even be poisoned. [2]

### Care of sick/injured animals and emergencies

Checking on the transported animals regularly to identify sick or injured animals is important.

To react well in emergencies or in case of an accident, a robust communication device, warning devices to inform other drivers about the dangerous situation and a kit to

document the accident's circumstances (taking pictures) shall be on board. [2]

## 2.4.5 Loading and unloading

### Layout of loading area

The loading area should be well designed to reduce the chance of injury, distress or escape. A good design and proper construction will facilitate the loading, reduce stress and therefore improve animal welfare. The design must allow the handlers to identify animals, which are unfit for travel visually. [2]

The importance of a reduced slope, well positioned foot battens and anti-slip coating of the loading ramps, as well as a sufficient source of light, that shouldn't blind ascending or descending animals, is highlighted by the guide. Cattle should preferably move from darker to lighter areas and no shadows or contrasts should obstruct the way. [2]

Vehicles and loading areas should be equipped with mechanisms, that allow the loading angle to be adjusted and set as close to zero as possible. E.g. loading docks or adjusting the ride height of the vehicle might be useful in that matter. The ramps shouldn't provoke glare, so covering them with litter is advisable. Also, the ramps should be rigid and shall not sway, even if multiple heavy cattle are loaded simultaneously. [2]

### Layout of the unloading area

It should be easy for the arriving driver to identify the assigned dock for unloading. Signals can be used for identification. Just as for loading, the quality of the floor is essential. Anti-slip surfaces, low angles of the ramps and adequate lighting make the process of unloading safer and less stressful for the animals. Cattle prefer to move on flat (0° angle) ground or slightly uphill and from darker into a lighter area.

The unloading area shall provide protection from the weather and be designed in a way, that the animals aren't unloaded facing the sun and suffer from the glare. [2]

### Unloading operating procedure

Upon arrival, waiting times should be avoided. The unloading shall start as quickly as possible to maximize animal welfare. The unloaded animals shall be checked right away

on the dock. [2]

Unloading can be highly efficient without the use of force. Trained personnel and the use of flags can produce the quickest unloading times. [19]

It is reasonable to change the order of unloading under specific circumstances. Animals from trucks with insufficient ventilation or similar complication that endanger animal welfare shall be unloaded first. The waiting trucks should be parked being protected from the weather. Keep waiting times as short as possible. [2]

### Cleaning and disinfection of vehicles after unloading

For washing and disinfection of the truck, proper lighting shall be provided, 400 Lux at least. Also, the tyres and the underside of the truck must be disinfected sufficiently to avoid contamination.

The disinfection area shall be designed in a way that avoids the pollution of the surrounding area, e.g. the stables or the streets. [2]

## 2.4.6 Stay at the control posts

### Housing

Cattle welfare, as well as the microclimate of the housing is influenced by space allowance, ventilation system, floor type, amount and availability of shade and environmental enrichment devices. [20]

The regulation EC 1/2005 states, that after a given journey duration the animals shall be unloaded and given time to eat drink and rest before the journey may continue. [8, Annex I, chapter 5, paragraph 1.5.]

Assembly centers and control posts should be suitable in capacity for the unloaded animals and provide sufficient feed, water, care and protection from the weather to allow resting and recovery from the journey. [2]

A drained floor, that provides sufficient grip and stability adjusted to the category of cattle kept on shall be installed. It is of importance to choose a floor material, that can be cleaned properly.

The light management shall avoid strong contrasts, reflection or glare, while providing at least 40 lux in the pens, 250 lux in the nursery pen and 100 to 150 lux in the (un)loading area, as well as the milking parlour.

At least one adequate fire extinguisher should be placed in each building of the facility. Testing all functions of the equipment and the facility before the arrival of new animals is recommended. [2]

### Temperature and space management

The temperature in the centers or posts should range from 5°C to 25°C. This range is called thermo-neutral zone and suitable for the cattle kept there temporary. For ventilation, a mechanical or passive ventilation should be installed. It's useful for the regulation of the temperature and providing good air quality. [2]

Providing adequate shade is helpful in temperature conditions outside of the thermo-neutral zone to reduce heat stress and potentially increase performance. [21]

If the temperature in the facility is below the acceptable limit, additional heating shall be provided. If the temperature is above the acceptable limit, fans for better ventilation shall be activated. Also, water sprayers can be used and more floor space can be provided to reduce heat stress. Mobile barriers shall be available to separate groups of animals, if desired. They should be constructed in such a way, that they do not pose a danger to the animals. [2]

There are set space allowances for cattle in check points and assembly centers. The six animal categories, defined by the bodyweight and age, require a specific minimum of space each.

Small calves of approx. 50 kg of weight shall be provided with 0,4 m<sup>2</sup> per head.

Medium sized calves of approx. 110 kg of weight shall be provided with 0,7 m<sup>2</sup> per head.

Heavy calves of approx. 200 kg of weight shall be provided with 1,1 m<sup>2</sup> per head

Medium sized cattle of approx. 325 kg of weight shall be provided with 1,5 m<sup>2</sup> per head.

Heavy cattle of approx. 550 kg of weight shall be provided with 2,2 m<sup>2</sup> per head.

Very heavy cattle of approx. more than 700 kg of weight shall be provided with 3 m<sup>2</sup> per head. [2]

## Feed and water

The important function of the control is, to give the transported animals a chance to recover from their journey. That includes rest, but also the sufficient intake of water and feed. Especially feeding is extremely difficult during the journey on the road, if it isn't impossible.

Providing the animals with adequate feeding and watering ensures animal welfare during the regulated resting period. [2]

Some cattle with a relatively low level of water intake still consume about 24 litres of water a day. The level of intake can go up to more than 60 litres. Dry matter intake can vary between 9,3 kg and more than 13 kg a day. [22]

The feed shall be stored in a closed barn, clean and dry. Contamination of the feed must be avoided, for that reason the building is recommended to be used only for the storage of feedstuffs. Chemicals of any kind shouldn't be stored in the same building/barn. Sufficient pest control shall be set in place.

Competition between the animals while feeding and contamination of the feedstuffs should be minimized by the type of feeding system installed. [2]

The animals can be fed ad libitum or restricted. For ad libitum feeding, a minimum of one feeding place for every 10 cattle in the group shall be available.

If a restricted feeding system is used a minimal feeder space per animal is defined. Also all animals of the pen shall be able to consume the feed simultaneously.

For calves before weaning, an individual feeder per animal with a capacity of 2l shall be provided.

Calves after weaning shall have at least 0,34m of feeder space each.

Cattle with a weight of 400kg or less shall have at least 0,50m of feeder space per head.

Cattle with a weight over 400kg shall have at least 0,65m of feeder space per head.

Cows shall have at least 0,70m of feeder space each.

The feeding system must allow to be cleaned and disinfected after each batch of resting animals. [2]

Access to clean water, provided ad libitum shall be given always. For that, the drinkers must be installed in a way appropriate for the size and age of the animals to drink in a

natural position (standing) and sufficient head space above (60cm). Two drinkers per pen must be installed, without causing an obstruction for the animals and the water flow must be adjusted according to the species. It's also important, that the drinkers, by design, can be drained completely and cleaned.

Special attention is needed, when providing water to calves. Drinking cold water can cause digestive upsets and diarrhoea in calves. For that reason, it is recommended to offer them warm water, around 30°C, or electrolytes instead. [2]

### Biosecurity, cleaning and disinfection

An important aspect of animal welfare is mentioned in the „5F“s, it's „*the freedom from disease*“. [1]

„*Biosecurity is a key component of any animal and public health strategy and disease prevention and control programs.*“ [23]

Biosecurity measures try to limit the spread to pathogenic germs by implementing hygienic concepts and therefore prevent animals from falling sick and suffering. Check points and assembly centers are regulated by EC 1255/97 to achieve an adequate level of biosecurity. According measures are listed below. [2]

Hygienic routing separates external and internal transports to avoid the import of pathogens into the facility. The routes are clearly marked for easy implementation of the concept, also the facility is divided. For planning a 3-zone system is implemented. Zone 1 includes the main entrance and the office buildings, zone 2 the storage buildings, truck washing facilities and driver accommodation and zone 3 includes the stables for the animals, parking lot for the trucks and waste storage facilities. [2]

The control post must be prepared for the loss of animals. Dead animals must be stored in a special way. The carcasses must be chilled and stored in a closable container or separate building. The storage facilities must be cleaned and disinfected after use. [2]

Stables must be marked clearly and only be entered by the facility staff, wearing clean cloths and disinfecting the shoes before. Removal of waste, cleaning, washing and disinfection of the animal buildings and used equipment can only take 24 hours after removal of the last batch. The building must be dried before housing animals again. Only authorized disinfectants shall be used. [2]

To limit the risk of importing pathogens into the facility, changing rooms, washing basins, toilets and showers shall be provided in another building, separated from the animal building.

Communication facilities shall be available on the control post, including a list of relevant contacts like vets, medical services, etc. All necessary informations about the facility shall be found online on a designated website.

The water supply system of the facility must be designed and constructed in a way, that allows flushing with a sanitizer, if needed, also the feed and bedding stored at the facilities must be secure from contamination and the equipment used for handling said materials shall be cleaned and disinfected after every single use. [2]

## 2.5 Critical points of animal welfare during road transport

### 2.5.1 Thermal stress of cattle during long journeys by road

The obligation of temperature management, passive or active, is enshrined in the regulation EC 1/2005 to ensure animal welfare during transport. [8, Annex I, chapter 6, paragraph 3.1-3.4.]

It's importance for transport of cattle by road is also confirmed in the study „*Untersuchungen zur thermischen Belastung von Schlachtrindern beim Straßentransport auf Langstrecken*“ by Christian Brüser-Pieper.

In the study, 15 journeys from the north of Germany to Italy, with a mean duration of 23,5 hours were documented and blood samples of 188 cattle were taken. By doing the blood work and collecting the data of different blood parameters, an overview of the heat stress level of the animals in relation to the temperatures during the transport was produced. The THI (Thermo Humidity Index) was used for definition of a critical value regarding the animal's health.

The study concludes that the causes of critical situations concerning heat stress for cattle in this scenario are mainly the prolonged standstill of the transport vehicle and extremely high outside temperatures (>28°C).

Also, it is concluded, that by complying with the space allowances set by the regulation EC 1/2005 and adequate planning of the journey, e.g. avoiding extreme weather conditions, the

arrival of the transported cattle in good condition can be achieved under most circumstances. [3]

### 2.5.2 Transport and rest stop duration's influence on conditioned cattle transported by road

The duration of a journey and obligatory resting times for the animals are defined by the regulation EC 1/2005.

Weaned cattle can be transported by road for 14 hours, before a break of an hour for drinking, feeding and resting should be planned. [8, Annex I, chapter 5, paragraph 1.4. (d)]

The Canadian law restricts the maximum duration of travel for weaned calves to 36 hours, before they need to be rested for 8 hours. [24]

The weaned calves with a mean body weight of 258kg and 7 to 8 months of age were transported for either 12 or 36 hours before a resting stop of defined length was taken. After the resting period the transport continued for another 4 hours until arrival at the destination. The resting period varied between 0 hours and 12 hours. Blood samples and body weight were taken and the changes in defined parameters were connected with the duration of journey and resting periods. Standing and laying periods of the transported calves were recorded and evaluated for the next 14 hours after transport and the feeding behaviour of some calves was recorded for 28 days after arrival at the destination.

The study concludes, that the duration of the journey can be proven to have an influence on the animal welfare of the calves. They do benefit from shorter journeys in comparison to longer journeys.

The duration of the resting periods couldn't be proven to have a definite influence on the welfare in this scenario. [4]

### 3. Methods

Using the regulation EC 1/2005 as a legal basis and minimum requirement regarding animal welfare during transport, the „Guide to good practices for the transport of cattle“ was screened for propositions of technical nature to improve animal welfare or to facilitate the compliance with the legislation.

By reviewing additional literature and collecting key points regarding animal welfare during transport, technical propositions were formulated for the authorized transporters, the keepers at assembly centers and checkpoints and to some extent for the competent authorities.

The propositions were presented in correlation with their legal counterparts in form of tables.

## 4. Results and discussions

Of the many propositions listed in the *guide to good practices for the transport of cattle*, regarding the technological aspects, temperature management and reduction of the journey duration are key points to ensure an acceptable level of animal welfare in a transport scenario. [2,4]

Further, increasing the effectiveness of surveillance of the animal's conditions (e.g. in the form of ABMs) is recommended to monitor the welfare situation, even under perfect transport conditions. [17]

The three protagonists of animal transport, namely the authorized transporter, the authorized keeper at checkpoints or assembly centers and the competent authority are obliged by the legislation to protect the animals from unnecessary suffering at any point of the journey. [8, Article 3]

The enhanced use of technological systems beyond the legal requirements can be a tool to ensure compliance with EC 1/2005 in certain cases.

Prevention of, or quick reaction to, questionable animal welfare situations are not only legally enshrined in the legislation, but desirable from a production standpoint. [2]

Based on the literature reviewed, the following proposals of technical nature can be made to enhance animal welfare during transport:

## 4.1 Authorized transporter

	Legal requirements	Systems to enhance animal welfare
<u>Temperature</u> management	<p><b>Temperature</b> during transport should be <b>5-30°C</b>, deviations of maximum 5°C are tolerated. <b>Mechanical ventilation systems</b> must be installed for <b>long journeys</b> over 8 hours. Two <b>temperature sensors</b> must be installed to monitor compliance. [8, Annex I, chapter 6, paragraph 3.1-3.4.]</p>	<p>The guide proposes the use of <b>mechanical ventilation in general</b>. It is recommended to use vehicles equipped with <b>climate control</b>, if the temperature inside the vehicle can't be kept below 30°C for non-lactating and below 21°C for lactating cows. Automatic <b>surveillance of the drinker-system</b> limits the risk of dysfunction and hence inadequate water uptake. [2] <b>Standstill</b> of the vehicle should be <b>limited to a minimum</b> by proper planning, avoidance of heavy traffic and long-lasting checks at border crossings [3]</p>
<u>Reduction</u> of journey duration	<p><b>Duration of journey</b> should be kept as short as possible and delay shall be <b>limited to minimum</b>. [8, Article 3] For the good of the animals the duration of the <b>journey</b> can be <b>prolonged</b> for a maximum of <b>2 hours</b> beyond legal limit, if needed. [8, Annex I, chapter 5, paragraph 1.8.]</p>	<p>The guide recommends the use of <b>commercial software</b> for the <b>planning</b> of the route, which takes legal driving hours, required stops for feeding or resting, traffic and weather into account. Further all <b>paperwork</b> should be filled in correctly and <b>transmissible electronically</b> in real time to <b>reduce the duration</b> of checks and (un-)loading [2]</p>
<u>Surveillance</u> of animal welfare state	<p>The <b>animals</b> have to be <b>checked</b> at stops, during loading and unloading to ensure animal welfare and fitness. [Article 3]</p>	<p><b>Camera systems</b>, which allow the driver to check on the animals and <b>estimate</b> their <b>welfare</b> condition based on the visual information <b>while driving</b>, are recommended by the guide. <b>Additional sensors</b> to monitor more parameters provide additional information to be taken into account. [2, 17]</p>

Table 1: Authorized transporter; Legal requirements in comparison to propositions of technical nature to enhance animal welfare during transport

The authorized transporter has plenty of options to increase animal welfare beyond the legal minimum. The technological proposals' goal include enhancing temperature management during the transport by effective ventilation and climate control systems, reducing the journey duration by real time information transfer and the use of updating databases during the stage of planning, as well as installing systems on the vehicle, that allow the monitoring of ABMs and their interpretation to evaluate the welfare situation during the transport.

## 4.2 Authorized keeper at checkpoints or assembly centers

	Legal requirements	Systems to enhance animal welfare
<u>Temperature</u> management	The temperature in buildings of check points should be kept in the <b>thermo-neutral zone</b> by adequate ventilation, insulation or heating. The <b>legal space allowance</b> must be complied with while doing so. [8, Article 8]	<b>Mechanical ventilation</b> systems and the <b>modification</b> of the <b>space allowances</b> within the legal limits are recommended. Automatic <b>surveillance</b> systems of the <b>watering system</b> can prevent negative consequences of inadequate water uptake. [2]
<u>Reduction</u> of journey duration	Duration of journey should be kept <b>as short as possible</b> and delay shall be limited to minimum. [8, Article 3]	The <b>electronic transfer of information</b> regarding the time of arrival of a truck and the conformation of required <b>paperwork</b> before arrival at the checkpoint can <b>reduce</b> the <b>duration</b> between arrival and unloading of a truck. [2] Loading and unloading <b>ramps</b> should be <b>adjustable</b> in a way, that the angle is as close to 0° as possible to facilitate the process and reduce stress. <b>Adjustable light</b> systems shall be installed. [2] The <b>personnel</b> shall be <b>equipped</b> with the proper tools for (un-)loading. [19]
<u>Surveillance</u> of animal welfare state	The animals at the facility must be monitored to <b>ensure adequate</b> feeding, watering and <b>resting</b> . [8, Article 8]	In addition to inspection of the animals during (un-)loading and feeding, a <b>camera system</b> can be installed to <b>monitor behaviour</b> while staying on the post. <b>Sick</b> or fighting <b>animals</b> can be identified more easily and be separated. [2, 17]

Table 2: Authorized keeper; Legal requirements in comparison to propositions of technical nature to enhance animal welfare during transport.

The keeper at a checkpoint can influence the animal welfare greatly by providing optimal thermal conditions for the resting and recovering cattle with help of an effective ventilation, heating or climate control system. Also stress and duration of the process of loading or unloading can be reduced by the use of modern and adequate docks, ramps and equipment. A camera system observing the behaviour of the animals at the facility allows to monitor ABMs and therefore to estimate the animal welfare situation remotely.

### 4.3 Competent authority

	Legal requirements	Systems to enhance animal welfare
<u>Temperature</u> management	Competent authorities are allowed to do random <b>checks</b> at <b>any point of a journey</b> . By measuring the temperature of the vehicle's inside, unacceptable temperatures can be detected. [8, Article 15]	The <b>recording</b> of the <b>temperature readings</b> provided by sensors can be collected and <b>checked</b> after the journey to detect infringements with the legislation. Also, the <b>real time transmission</b> of the readings would be an option. [2]
<u>Reduction</u> of journey duration	The <b>authorization</b> of a long <b>journey</b> only occurs if the <b>legislation</b> of animal transport <b>is complied with</b> . This includes to minimize the duration of the journey. In case of traffic jams or other <b>emergencies</b> , that can prolong the duration of a journey, the transporter should be <b>assisted to limit the delay</b> . [8, Article 14, Article 22]	<b>Software</b> for the planning of the route, which takes legal driving hours, required stops for feeding or resting, traffic and weather into account can be used to <b>check</b> , if the <b>routing</b> proposed by the transporter is <b>optimized</b> . [2]
<u>Surveillance</u> of animal welfare state	Competent authorities are allowed to do <b>random checks</b> at any point of a journey. [8, Article 15]	<b>Additional</b> to the <b>recordings</b> of the navigation system, recordings of <b>sensors</b> or <b>camera</b> systems onboard can be <b>checked</b> to detect infringements with the legislation. [2]

*Table 3: Competent authority; Legal requirements in comparison to propositions of technical nature to enhance animal welfare during transport.*

Technological proposes to the competent authority are mainly based on the idea to increase the efficiency of the random or targeted checks of the transporter's compliance to regulation EC 1/2005. Checking data collected by electric surveillance systems like sensors or cameras remotely, allows to increase the rate of checks while limiting the delay caused to the transporter while doing so.

The enforcement of the European legislation is a crucial factor for animal welfare, especially in long journeys and export to third country scenarios. Competent authorities require effective tools to evaluate, if the planning of a journey can be deemed realistic in

accordance to regulation EC 1/2005 and therefore can be authorized. Recently taken satellite images can be used to check if checkpoints or other facilities actually exist and to some extent in which state they are. [25]

Adequate watering of cattle during the transport requires the animals to be used to the type of drinker system installed on the vehicle. [2]

The total water intake can be estimated by checking the level of the water tanks at refill stops, but individual water intake is hard to evaluate.

Improvement of the drinker-systems by measuring the individual intake could be made possible by a *smart sensing system of water quality and intake*, like mentioned by Tang et al.

The system works based on individual animal identification by RFID, sensors measuring the water level, temperature and flow and cameras. [26]

Other aspects, which endanger animal welfare during transport are listed in the EFSA Panel on Animal Health and Welfare and include undertrained handlers and therefore inadequate handling practices, as well as poor driving skills. [5]

In the regulation EC 1/2005 lack of education is also mentioned to be a main reason for poor animal welfare. [8]

Additional to the obligatory training, self-regulated learning could be improved by offering a mobile application with gamification elements to boost motivation to learn and battle the lack of education. [27]

## 5. Conclusion

It can be concluded, that the use of updated technology can have a positive influence in multiple aspects of animal transport.

The extended surveillance of ABMs facilitates to recognise critical animal welfare situations and can potentially reduce the time to react upon them.

Extended surveillance devices include visual systems like cameras and sensors monitoring the environment inside the vehicle during transport.

Improvement of temperature management, e.g. mechanical ventilation or climate control systems reduces the chance of exposing the transported animals to thermal stress. This advantage shows mostly in scenarios with extended periods of standstill of the vehicle or in case of very warm weather conditions.

A connection between space allowance and temperature management can be implied. The correct combination of both will help reduce heat stress during the journey.

The use of commercial software and real time information exchange during the planning stage of the journey and during the journey can help to reduce the duration of the journey or at least limit delay.

Real time information exchange by communication, transfer of documents or unlimited access to databases containing critical information play major roles in the reduction of journey duration.

Nevertheless, the use of technology will not increase animal welfare during transport by default. The personnel need to be able to use the provided technology properly. The importance of well executed training has to be highlighted. Technology is always susceptible to fault and cannot be trusted blindly.

Another aspect that has great influence on animal welfare is the enforcement of the legislation in general. Without enforcement, the animal welfare benefits provided by the regulation EC 1/2005 are of purely theoretical nature. [25]

Also, it needs to be questioned if all rules set by the regulation EC 1/2005 are based on scientific evidence that can withstand critical re-evaluation. Further research regarding animal welfare in general and specifically regarding welfare during the process of transportation is required.

## 6. Summary

The transport of animals presents a multitude of challenges of organizational, logistic and technological kind.

Animals are living creatures and therefore require very specific conditions to survive the journey unharmed. The margin of error during the process of transportation is extremely narrow and any mistake will cause suffering or even death of the animal. A steady supply of water and feed, as well as ventilation and temperature management are essential.

The European Union regulates the transport of animals strictly. EC 1/2005 defines obligations of the member states, competent authorities, authorized transporters and assembly centers with the goal to minimize animal suffering and to create a legal minimum of animal welfare during transport.

The guide to good practices for the transport of cattle is a legally not binding document commissioned by the European council to facilitate the compliance with the legislation and to improve animal welfare beyond legal minimum.

It's technical proposals regarding the extended surveillance of animal-based measures, extended temperature control during transport and reduction of the journey's duration is summarized. The importance of a functioning watering system during transport, adequate space allowances surpassing legal minimum and well-constructed (un-)loading facilities are highlighted.

In scientific literature it is concluded that the causes of critical situations concerning heat stress for cattle transported in central European climate conditions are mainly the prolonged standstill of the transport vehicle and extremely high outside temperatures (>28°C).

The duration of the journey can be proven to have an influence on the animal welfare of the calves. They do benefit from shorter journeys in comparison to longer journeys.

Resulting in the research it is stated, that authorized transporters, authorized keepers at assembly centers and also competent authorities can use technical systems or devices proposed by the literature to extended surveillance of animal-based measures, to improve temperature control during transport and to reduce the journey's duration.

These changes are considered as improvements and believed to have a positive influence

on animal welfare.

Nevertheless, the use of technology will not increase animal welfare during transport by default. A multitude of additional factors influence it, including handling, physical condition, grouping and many more.

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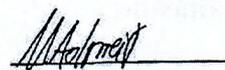
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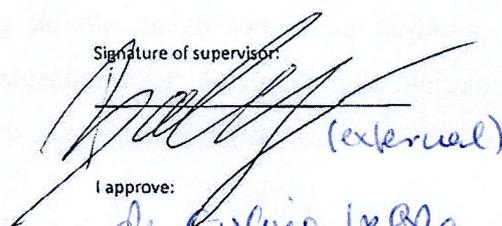
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Kijelenti, hogy az átadott dokumentum az Ön műve, és/vagy jogosult biztosítani a megállapodásban foglalt rendelkezéseket arra vonatkozóan. Kijelenti továbbá, hogy a mű eredeti és legjobb tudomása szerint nem sérti vele senki más szerzői jogát. Amennyiben a mű tartalmaz olyan anyagot, melyre nézve nem Ön birtokolja a szerzői jogokat, fel kell tüntetnie, hogy korlátlan engedélyt kapott a szerzői jog tulajdonosától arra, hogy engedélyezhesse a jelen megállapodásban szereplő jogokat, és a harmadik személy által birtokolt anyagrész mellett egyértelműen fel van tüntetve az eredeti szerző neve a művön belül.

A szerzői jogok tulajdonosa a hozzáférés körét az alábbiakban határozza meg:

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Amennyiben a feltöltés alapját olyan mű képezi, melyet valamely cég vagy szervezet támogatott illetve szponzorált, kijelenti, hogy jogosult egyetérteni jelen megállapodással a műre vonatkozóan.

A HuVetA üzemeltetői a szerző, illetve a jogokat gyakorló személyek és szervezetek irányában nem vállalnak semmilyen felelősséget annak jogi orvoslására, ha valamely felhasználó a HuVetA-ban engedéllyel elhelyezett anyaggal törvénysértő módon visszaélne.

1078, 3/27/2023

I hereby confirm that I am familiar with the content of the thesis entitled

ASSURANCE OF FARM ANIMAL WELFARE DURING TRANSPORT BY THE USE OF MODERN TECHNOLOGY

written by Marius Alexander Adomeit

which I deem suitable for submission and defence.

Date: Budapest, .....day .....month .....year

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Supervisor name and signature

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