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To the Inspector-General of the Netherlands Food and Consumer Product Safety Authority

Advice of the Director of the Office for Risk Assessment and Research

Animal welfare, animal health and food safety risks of the Mobile Slaughter Unit pilot in the Northern Netherlands region

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Background

Since December 2018, the NVWA has been running a pilot programme with the mobile slaughter unit (MSU) for cattle in the Northern Netherlands region. The pilot aims to examine whether the stunning and slaughter of animals that are fit for slaughter but not fit for transport can be carried out at the farm through the use of the MSU. Most of the animals that are not fit for transport will then be stunned and slaughtered in the MSU, whereas a small number of animals, who are unable to walk into the MSU, will be killed in the barn or in front of the MSU. All animals, however, will be bled inside the MSU, after which the carcasses are transported to the slaughterhouse in the MSU for further processing. A second disposal pathway for a specific, small group of animals that are not fit for transport is through emergency slaughter. Only animals that have suffered an acute accident and which are stunned and killed by bleeding on the farm by a practising veterinarian within three days are eligible for emergency slaughter, after which the carcass must be delivered to the slaughterhouse for slaughter within two hours.

In the spring of 2019, there was a debate both within and outside the NVWA regarding the potentially insufficient of safeguarding animal welfare, food safety and animal health risks in relation to the use of the MSU. In response, at the end of September 2019, the Inspector-General of the NVWA (IG-NVWA) requested the Office for Risk Assessment & Research (BuRO) to produce an advisory report on the use of the MSU and the potential associated risks to the public values of animal welfare, animal health and food safety.

The question of the IG-NVWA has been translated into two research questions:

1. What is the impact of the MSU on the welfare of individual animals that are offered to the MSU and the impact on the population as a whole?
2. What are food safety, hygiene and animal health risks associated with the use of a mobile slaughter unit?

Approach

In order to answer the question put by the IG-NVWA, BuRO initially carried out specific desk studies into the use of MSUs in other countries. In addition, an analysis took place of the information available from the pilot between December 2018 and July 2019. Due to the fact that insufficient detailed information had been collected and documented during the pilot to allow the questions to be answered, additional information was collected between 20 November and 20 December 2019 at the request of BuRO.

Furthermore, a data analysis was carried out into the potential differences in a number of key figures of dairy farming, such as average farm size and disposal rates, of suppliers to the MSU, from dairy farms in the Northern Netherlands as a region and in the Netherlands as a whole.

Subsequently, the risks in the scenario using the MSU were compared with the scenario without the MSU, in which animals would be disposed of via other channels, such as emergency slaughter, through euthanasia or via routine transport to the slaughterhouse. The estimated relative risks have been assessed for the probability of occurrence and impact. There is little concrete data available to allow a quantitative assessment to take place. The relative risks therefore are shown in qualitative terms such as 'higher', 'lower' or 'equal'.

To conclude the information phase, BuRO held a meeting with the NVWA inspectors/veterinarians that were involved in the fact-finding process. This meeting compiled the joint impression of the inspections as well as the difficulties and areas of focus for a possible continuation of the MSU.

Findings

Comparison of the MSU in the Netherlands with foreign initiatives and mobile slaughterhouses (MS)

- In several countries, there are concepts of mobile slaughterhouses and mobile slaughter units, which are similar to the Dutch MSU.
- In the Dutch MSU, animals are killed on site (primarily in the MSU, but in the housing unit, if necessary) and bled, after which the carcasses are transported to the slaughterhouse for further processing.
- In a mobile slaughterhouse (MS), animals are killed on site (in the MS or at the farm) and bled, after which processing and chilling of carcasses takes place within the unit.
- Most mobile slaughterhouses and MSUs abroad (including in Germany, Switzerland, Sweden and Austria) were or are used for the slaughter of (high-quality) beef cattle, often in small specialised sectors.
- In the Netherlands, the MSU is primarily focused on the use and optimisation of lower quality animals. Livestock farmers supply animals that they believe are fit for slaughter but not fit for transport.
- Key operational differences in the circumstances under which animals are stunned or slaughtered between the MSU in the Netherlands and the MS or MSU abroad are:
    - A fixation box is generally used outside the 'MSUs' abroad, in which animals are shot, whereas in the Netherlands animals are preferably shot inside the MSU.
    - In the Netherlands, animals must enter the MSU, provided they are sufficiently mobile, and must be placed behind a barrier.
    - Outside the Netherlands, animals are killed by bleeding within 60 seconds and carcasses must be delivered to the slaughterhouse for further processing within 45 – 60 minutes. In the Netherlands, there are no such time frames laid down by law.

Design of the pilot and MSU target population

- The principal category of animals in the pilot has previously been animals in the cull dairy cattle category and weak and/or injured cattle in particular, which were not fit for transport but were fit for slaughter.
- In an MSU, animals are killed on site (primarily in the MSU, but in the housing unit if necessary) and bled, after which the carcasses are transported to the slaughterhouse for further processing.
- The interpretation (of the definition) of fitness for transport was ambiguous.
- The data analysis of the key figures for average mortality, disposal rate (replacement rate) and average animal age shows no differences between the farmers who supplied their animals to the MSU and those of other dairy farmers in the Northern Netherlands region or those of the Netherlands as a whole.
- The farms that supplied animals to the MSU were larger in size (average of 146 animals older than 2 years) than on average in the Northern Netherlands region (119 animals) or in the Netherlands as a whole (100 animals).
- In 2019, approximately 300,000 animals over the age of 2 years were supplied to Dutch slaughterhouses in the Netherlands from dairy farming, with a further 100,000 animals being supplied to other livestock farms or exported to surrounding countries. As such, in 2019, the replacement rate in dairy farming amounted to approx. 28%. This rate is similar to that of other Western countries, such as Scotland, Sweden, Canada and the United States, with an intensive, highly productive dairy farming sector.
- In order to estimate the size of the group of animals suitable for the MSU, BuRO has used the definition of weak and/or injured cattle ('wrak vee')[1] of the Council on Animal Affairs (Raad voor Dierenaangelegenheden, RDA). In 2007, the RDA estimated the minimum size of the group of sick and injured cattle in the cattle sector to be some 28,000 animals.[2] In conjunction with the NVWA's slaughter data on red meat (Roodvlees Slachtgegevens, RSG) (2017-2019), the estimated size of the animal population for which the MSU may be used is at least several tens of thousands of animals per year. Due to the ambiguous interpretation of fitness for transport, the upper limit cannot be determined.
- The key reasons for replacing dairy cattle, which is disposed of as cull dairy cattle are: lameness, fertility problems, insufficient production and poor udder health.
- Initiatives also appear to be developed for the use of a mobile slaughterhouse for other farm animals.

[1]'Animals that are more than slightly injured or more than slightly sick. Downer animals are per definition no longer fit and can therefore no longer be transported' (RDA, 2007).
[2]The number of dairy cattle over the age of 2 has increased from over 1.4 million in 2006 to 1.6 million in 2019 (source: www.agrimatie.nl).

MSU method and BuRO observations during MSU and slaughterhouse inspection

- The registration of the animals for the MSU is organised by Slachthuis Dokkum. Following registration, pre-screening of animals that are eligible for the MSU takes place, after which the slaughterhouse submits a request for ante mortem (AM) inspection to the NVWA and determines the trajectory.
- The official NVWA veterinarian (TDA) is present during the activities of the MSU on the primary livestock farm, where he or she carries out the ante mortem inspection and also supervises the correct stunning and bleeding of animals.
- NVWA veterinarians have reported that there is time pressure on their work due to the tight logistical schedule.

Available data for MSU pilot

- Between December 18, 2018 and December 20, 2019, 922 different farms supplied the MSU with a total of 1934 animals. These were primarily dairy farms. Nearly 10% of the animals were denied access to slaughter at the ante mortem inspection (Dutch: 'Geen Toestemming tot Slacht', GTS) due to their unfitness for slaughter (unfit for slaughter for human consumption).
- The main reasons for supply to the MSU was lameness (between 65-80% of the animals), followed by recumbent or 'downer' animals (10-13%). The other animals were supplied due to various other incidental reasons.
- The majority of farms (two thirds) only supplied 1 animal to the MSU and approximately a quarter supplied 2 animals during this period. Roughly 8% of farms supplied three or more animals.
  The pilot showed a monthly increase in the number of animals supplied with a peak in November 2019 of 245 animals. During the pilot, there was hardly any difference per quarter in the reason for disposal. The percentage of animals refused for slaughter (GTS), however, showed a slight decrease over the course of the pilot.

Fact-finding process at BuRO's request

- During BuRO's orientation phase, it was established that insufficient information was available to allow a minimum type of risk assessment, upon which BuRO submitted a request to the Inspection and Enforcement directorates for more data to be collected, including by way of joint random controls aimed at various aspects, such as monitoring the degree of lameness of the animals supplied, their fitness for transport, a 'professional first impression' of the livestock farm as well as analysis for residues of veterinary medicinal products.
- Based on both, the assessment of the completed checklists at the joint inspections and on the concluding meeting with Inspection and Enforcement inspectors, the following impression emerged, namely that there are no effective agreements in place regarding the translation of locomotion scores as a measure of fitness for transport.
- The Food Chain Information (FCI or in Dutch 'Voedselketeninformatie, VKI') form is regularly completed with very minimal information and had to be adapted when attending the MSU. NVWA veterinarians seem to have insufficient time available to carry out a full check of the accuracy of the VKI.

Risk assessment

The key risks to animal welfare are:

- In the scenario with the MSU, refusal of access to slaughter, resulting in animals remaining at the farm due to the ante mortem inspection, may lead

to higher risks to animal welfare, with existing distress caused to animals continuing. In the scenario with the MSU, there is a higher likelihood of refusal of access to slaughter, with animals remaining at the farm.
- Animals supplied to the MSU having to walk to the unit, as well as having to enter the MSU. In the scenario without the MSU, some of the cull animals are disposed through routine transport and animals are stressed when loaded into the transport vehicle, during transport, when unloaded and at the slaughterhouse. The risk of avoidable distress is lower in the MSU scenario.
- Transport of animals to the slaughterhouse that are de facto unfit for transport, but are nevertheless transported in the absence of an MSU. For animals that are unfit for transport, there is a chance that their condition may worsen during transport. The risk of a higher welfare impact on animals as a result of transport to a slaughterhouse is greater in the non-MSU scenario.
- Based on the combination of the probability of incorrect stunning and incorrect bleeding, the risk of regaining consciousness is greater in the scenario using the MSU, compared to routine slaughter, and smaller compared to emergency slaughter.
- The risk of stress during the pre-slaughter process is greater for animals at the slaughterhouse compared to the use of an MSU and/or emergency slaughter.

The key risks to food safety are:
- Access to the slaughter process of animals unfit for slaughter. Given that in the MSU, the temperature of all animals is measured individually (in contrast to the procedure at regular slaughterhouses), with fever being a general indicator of illness, the likelihood of a sick animal being admitted for slaughter in the MSU is lower than at the slaughterhouse.
- Cutting of the animal in recumbent position before bleeding. In the MSU, this may take the form of a cut from ear to ear (‘open kop-slacht’), where the trachea and oesophagus are cut open. This may cause microbiological contamination of the tissue around the cut. In the case of emergency slaughter, in the scenario without an MSU, this may also be the case, however this will not be the case for animals that are bled at the slaughterhouse. The risk of contamination of the tissues surrounding the cut to the neck is greater when an MSU is used than at the slaughterhouse.
- Delayed evisceration. In the scenario with the MSU, visits are carried out to multiple farms and animals are killed in succession before the carcasses are taken to the slaughterhouse, resulting in the likelihood of evisceration being (significantly) delayed being greater than in the scenario without the MSU. Although the likelihood of the delayed removal is increased, there is only a limited increase in the microbial risk in terms of food safety in the scenario with the MSU.
- The presence of (veterinary) medicinal products in the meat. For animals that are supplied to the MSU, there is a higher likelihood of analgesics being administered to suppress fever. For animals in the live transport risk group, there is a higher likelihood of the use of analgesics to mask the unfitness for transport. For both groups of animals there is an elevated risk, however there is likely no difference between the scenario with or without the MSU.

The key risks to animal health:
- Transmission of animal pathogens between farms. This may be the case if the personal hygiene of the MSU employee is insufficient or if the cleaning and

disinfection of the MSU is sub-optimal. This risk is largely absent from emergency slaughter and euthanasia.
- The incorrect disposal of waste water in the MSU. Under current MSU working methods, waste water ends up in the blood collected from the bled animals and is processed as category 3 material[3]. Given that category 3 material can be used as animal feed, there is a slightly elevated risk, primarily in relation to pet animals, if this blood is used for the production of unheated animal feed.

Other observations:
- Although the NVWA veterinarian attending the farm at which the MSU is present could in principle verify the VKI forms based on the farm log, he or she has no time to do so.
- The lack of adequate administrative and IT support for NVWA veterinarians leads to limited or lack of up-to-date insight into the possible repeat submission of animals to the MSU.

Response to the questions

What is the impact of the MSU on the welfare of individual animals that are offered to the MSU and the impact on the population as a whole? If possible, the group of animals for which the MSU may be able to contribute to preventing (additional) welfare risks during transport to slaughter will also be identified.

The use of the MSU poses a lower risk to animal welfare for individual animals. This is principally due to the absence of the additional pressure and stress caused by routine transport and presence at the slaughterhouse. Based on the combination of the probability of incorrect stunning and incorrect bleeding, the risk of regaining consciousness is greater in the scenario using the MSU, compared to routine slaughter, and smaller compared to emergency slaughter. For a small group of animals that are refused access to slaughter at the ante mortem inspection, the use of the MSU results in a higher level of risk.

What are the food safety, hygiene and animal health risks that may occur with the use of a mobile slaughter unit?

The (additional) risks to food safety are limited and relate to the delayed evisceration, the possible contamination of meat around the neck cut and the potential entering into consumption of meat containing residues of veterinary medicinal products. The risk of residues, of painkillers in particular, is higher, however is expected to be equal to or even lower compared to the group of lower quality cull dairy cattle that is disposed of by routine transport. Reduced risk means that there is an increased risk of contamination of the meat with bacteria or an increased risk of the presence of veterinary animal products. This does not necessarily result in an increased risk of disease or increased exposure for consumers of that meat.

In the field of animal health, there is a risk of cross-contamination of animal diseases as a result of attendance at multiple farms on a single MSU route.

[3] For an explanatory note on the three categories of animal by-products, please see: https://www.nvwa.nl/onderwerpen/dierlijke-bijproducten/de-3-categorieen-dierlijke-bijproducten

BuRO advice

To the Inspector-General:

- Use the experiences that have been gained through the MSU pilot and this risk assessment to define and establish a better set of working protocols and framework conditions and recommend to the Minister of Agriculture, Nature and Food Quality that this be formally laid down.
- Draft specific framework conditions for each type of domestic animal and feral animal for which an MSU or mobile slaughterhouse is used.
- Monitor the high-risk group of animals in routine transport and those of the MSU periodically for the use of analgesic products.

Yours sincerely,

Prof. Antoon Opperhuizen
Office for Risk Assessment & Research

1. Substantiation

Introduction
Since December 13, 2018, a pilot with a mobile slaughter unit has been ongoing in the Northern Netherlands, with the slaughterhouse Slachthuis Dokkum acting as the operator and the NVWA as the supervisory authority. This process prompted a debate both within the NVWA as well as in the public domain and political arena regarding whether or not sufficient safeguards were in place for risks in the areas of animal welfare, food safety and animal health. In September 2019, the Enforcement and Inspection directorates were unable to agree on the evaluation of the pilot that was carried out between December 2018 and July 2019. On September 25, 2019, the director of Strategy submitted a request to the Office for Risk Assessment & Research (BuRO) to carry out a(n) (rapid) objective assessment of the MSU pilot that was carried out and, if possible, to relate it to (any potential risks to) animal health, animal welfare and food safety.

The following risk assessment will first of all outline the background for the execution of the pilot, followed by BuRO's action plan and methods, after which the details of the pilot as well as its progression will be examined.

In order to identify the underlying problems of the key target group of animals for the MSU, the risk assessment will focus on the problems faced by cull dairy cattle and the principal reasons for disposal of dairy cattle (also referred to as dairy herd replacement, cull cattle or end-of-career dairy cattle), criteria for fitness for transport and emergency slaughter.

Finally, a qualitative risk assessment will be set out for the values of animal welfare, food safety and animal health, which will zoom in on the differences between the various MSU disposal pathways, emergency slaughter, voluntary euthanasia of animals and the 'high-risk group' of cull dairy cattle, which is in a poorer condition, i.e. the category of sick and injured cattle that is transported to the slaughterhouse (potentially with a stopover at an assembly centre or another farm).

1.1. Background to the pilot (and preliminary process)
Between 2017 and 2018, in part following a request from Slachthuis Dokkum for the operation of a mobile slaughter unit, consultations were held between the Inspection directorate of the NVWA and the Animal Supply Chain and Animal Welfare Policy Department of the Ministry of Agriculture, Nature and Food Quality on the authorisation of an MSU and the corresponding framework requirements. Key considerations in this regard were the avoiding distress experienced by animals during transport to slaughter and the avoidance of wastage of animal proteins in the context of a closed-loop system. At the beginning of May 2018, the DG for Agriculture of the Ministry of Agriculture, Nature and Food Quality informed the Director of the NVWA that four categories of animals were eligible for slaughter in an MSU/Mobile slaughterhouse:

- animals designated for emergency slaughter (at present already normally permitted)
- feral animals in nature reserves
- animals that are not fit for transport but are suitable for human consumption and/or animals that may be transported, but in which case it is better not to do so for welfare reasons, and
- animals that are kept on farms for small-scale, animal-friendly meat production or 'short supply chains'.

In a Letter to Parliament of November 9, 2018, the Minister of Agriculture, Nature and Food Quality confirmed a previous verbal statement regarding a pilot with the MSU:

'In the debate on the abuses in pig housing units, I committed to keeping the House informed on the status of the 'mobile slaughter unit' concept and any potential pilots in this regard. Within the framework of the European Food Hygiene Regulation and Council Regulation 1099/2009 on the protection of animals at the time of killing, it will be possible for stunning and the first phase of the slaughter of animals to take place in a mobile slaughter unit, subject to strict conditions. This will yield opportunities for the transport of animals that cannot be transported or are difficult to transport to the slaughterhouse (such as injured animals, wild animals), but which nevertheless are fit for consumption, to be killed on site. Thus sparing the animal any suffering it would have experienced during transport. Investments in mobile slaughter units must be made by entrepreneurs. The NVWA is currently making preparations for a pilot with a mobile slaughter unit, which will be carried out and evaluated before the summer of 2019.'

At the end of October 2018, the Head of the Design & Services Division (O&D) of the Inspection directorate submitted a memorandum to the management of the Inspection directorate requesting that the 3-6-month MSU pilot should be approved subject to the conditions set out (Annex 1 Memorandum 18/10/2018).

1.2. Design of the pilot

Prior to the start of the pilot, a working protocol for the MSU was drafted by the Inspection directorate (Annex 2) and a team of executive supervising veterinarians (TDAs) was put together that would principally carry out the ante mortem inspections of the animals supplied. The point of departure was to gain experience with the MSU on the job in a practical setting. The team of executive veterinarians periodically consulted with their project leader to exchange experiences and to calibrate protocols if necessary.

Key changes during the pilot:

The pilot was kicked off with a first cohort of 50 to 100 animals on December 13, 2018 in accordance with the agreements made. This initial period saw the post mortem inspections carried out by the supervising veterinarians, checks were carried out for injection sites on the animal and a limited number of bacteriological hygiene analyses were carried out.

Following an interim evaluation of the first 73 animals that were supplied between December 13, 2018 and January 4, 2019, a decision was taken in mid-January that standard post mortem (PM) inspections would no longer have to be carried out by supervising veterinarians and that there was no reason to carry out additional checks for residues of veterinary medicinal products. PM inspections are carried out by default by an official assistant of the Animal Sector Quality Inspection Foundation (Kwaliteitskeuring Dierlijke Sector, KDS) in accordance with standard working methods.

In the initial months of the pilot, operating the MSU at a cattle (export) assembly centre was found to be undesirable and the Dutch national forest service (Staatsbosbeheer) (wild cattle) withdrew from further participation in the pilot.

Roughly from April 2019, the pilot began focusing on cattle unfit for transport, occasionally as an alternative to emergency slaughter, provided that this should take place within three days after an acute event had taken place, in accordance with the rules on emergency slaughter.

In the spring of 2019, a debate was prompted within the NVWA regarding the way in which the MSU was used in practice. It was subsequently agreed that two inspectors/veterinarians from the Enforcement directorate should be given the opportunity to conduct their own assessment of the implementation. These colleagues were therefore given access to the findings documented by the supervising veterinarians on so-called withdrawal notes. In addition, they conducted several visits to the MSU. The withdrawal notes assessed by the inspectors of the Enforcement directorate lead to a series of reservations regarding the implementation of the pilot and control of the risks during the pilot in respect of the Inspection directorate.

An internal NVWA evaluation took place in the months of July to September 2019 – no agreement could be reached on this matter.

At the end of September, BuRO was subsequently asked to draw up an objective examination of the facts. After BuRO established its working method on 24 October 2019, it began with the analysis of the information available at that time. On 14 November, a welfare expert and a veterinarian from the BuRO team carried out a visit to the MSU during its activities and on 20 November BuRO requested that more information should be collected, including in the form of random checks on the accuracy of the VKI forms completed and on the presence of residues of veterinary medicinal products, including painkillers. This additional information was obtained between November 20, 2019 and December 20, 2019.

On January 7, 2020, a consultation took place between BuRO and a number of employees from the Enforcement and Inspection directorates who were involved with the MSU, at which BuRO raised a number of clarifying questions.

1.3. Involvement of BuRO

1.3.1. Request from the Strategy directorate

On September 25, 2019, the director of Strategy submitted a request to the Office for Risk Assessment & Research (BuRO) on behalf of the Inspector-General of the NVWA for BuRO to carry out a(n) (rapid) objective assessment of the MSU pilot that was carried out and, if possible, to relate it to (any potential risks to) animal health, animal welfare and food safety. This was in response to the conclusion that the joint evaluation of the pilot, carried out by the Inspection and Enforcement directorates in the months of July to September, had not resulted in a unanimous conclusion.

1.3.2. BuRO project team and core team

Within BuRO, a project team, consisting of two animal welfare experts and two veterinarians with expertise in the field of both animal welfare and veterinary public health, jointly carried out the study. During the study, the project leader participated in a MSU core team alongside the BuRO department head on behalf of BuRO, which met on average every two weeks. The core team also consisted of secretary from the Strategy directorate, the Head of the Design & Services (O&D) division of the Inspection directorate and the acting Head of the Livestock department from the Enforcement directorate.

1.3.3. Scope of BuRO involvement

The BuRO project team primarily focused on identifying the potential risks to the public interests of animal health, animal welfare and food safety associated with the operation of the MSU in the Northern Netherlands. The BuRO advice explicitly relate to an in-depth evaluation of the risks outlined in the above and is emphatically not a 'comprehensive' evaluation of the project as a whole. BuRO's advice will be used as part of an evaluation report on the MSU pilot to be submitted to the Minister of Agriculture, Nature and Food Quality by the NVWA.

1.3.4. BuRO action plan

Based on the Director of Strategy's request, a draft action plan was drawn up at the beginning of October 2019 and discussed in the core team's consultation, resulting this provisional agreement:
BuRO was asked to conduct 'a narrow evaluation' of the MSU pilot 'and to identify broader issues'.

- Narrow: use of MSU and impact on implementation of AM inspection, stunning and killing, slaughter hygiene.
- Broad: what risks to animal welfare and food safety can be identified in relation to the use of the MSU and should be covered; a conclusive assessment of the current MSU pilot may not be possible based on the information available; potential follow-up pilot needed using a different format.

The narrower scope extends an invitation to the broader scope; a 2nd phase MSU pilot may be set up based on this evaluation, based on the broader issues identified.

Following this core group consultation, the Director BuRO decided that BuRO's recommendations **will focus on identifying the potential animal welfare, animal health and food safety risks associated with the MSU**, taking into account the following aspects:
A: the impact of the MSU on the welfare of individual animals that are supplied to the MSU and the impact on the population as a whole. If possible, the group of animals for which the MSU may be able to contribute to preventing (additional) welfare risks during transport to slaughter will also be identified.

B: any other risks in the field of food safety, hygiene and animal health that may occur through the use of a mobile slaughter unit.

This was elaborated in the action plan of October 24, 2019 as follows, with the following components being identified:

- A desk study: qualitative review of the dossiers drawn up by the supervising veterinarians during the implementation of the pilot
- A desk study into the potential risks associated with the use of an MSU
- A visit to the MSU (assessment of facilities and technology of the MSU)
- A desk study into the nature and scope of the welfare issues within the cattle population, which may lead to killing the animal on the farm or which make animals unfit for transport, though potentially suitable for slaughter.
- A desk study into the requirements that should be put in place for the use of an MSU from an animal welfare, public health and animal health perspective.

2. BuRO methodology and procedures

2.1. Risk assessment method

Animal welfare

The risk assessment is to be carried out on the basis of the European Food Safety Authority (EFSA) methodology for animal welfare, which has also previously been used for cattle (EFSA AHAW Panel, 2009;2012a;2012b). EFSA's methodology is in line with the 'Food Code' (Codex Alimentarius) (www.FAO.org) and Regulation (EC) No. 178/2002[4]:

1. Hazard identification: the threats to animal welfare that have been identified by academic experts and experts in professional practice and which have been described in international scientific literature,
2. Hazard characterisation: the relevance (welfare impact) consisting of the severity and duration of welfare,
3. Exposure assessment: the likelihood of threats, including the number of animals affected by them. In relation to animal welfare, this is the occurrence of certain conditions, situations and practices that affect the welfare of animals.
4. Risk assessment: the overall assessment of the nature and severity of each threat, and the likelihood/prevalence thereof in the Netherlands.

Steps 1 and 2 made use of a) the knowledge on the methods of the MSU, emergency slaughter, euthanasia and routine transport and slaughter, b) expert assessments from previous BuRO risk assessments of animal supply chains, and c) scientific literature. Step 3 used the same sources as well as the data analysis. Step 4 focused on identifying the deltas (differences) between MSU, emergency slaughter, euthanasia and the routine transport high-risk group.

Food safety and animal health

In order to put the risks to food safety or animal health associated with the MSU into perspective, the differences between regular slaughter and the MSU were examined initially, based on BuRO's own observations and the available information from the MSU pilot. An assessment was then made of how the risks associated with these differences related to the risks associated with the MSU, regular slaughter, emergency slaughter or euthanasia. The particularities of the MSU were identified for that purpose first of all. Subsequently, the four steps of the CODEX risk analysis principles were then applied as much as possible:

1. Hazard identification: per difference (MSU/regular), what are the potential hazards to food safety or animal health.
2. Hazard characterisation: what impact do the hazards identified have on animal health or food safety?
3. Exposure assessment: estimate of the risk of humans or animals being exposed to the hazards identified,
4. Risk characterisation: determining the extent of the risks in terms probability x severity; comparison level of risks identified for MSU with emergency slaughter, euthanasia and routine transport/slaughter

The sources used in this context are individual observation, MSU pilot documentation, expert opinions and literature review.

[4]Regulation (EC) No. 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety, Document 32002R0178.

2.2. Methodology Definition of search terms
General:

Animal welfare:

- A search was carried out for scientific publications using the SCOPUS search engine and searching titles, abstracts and keywords. The terms or combinations of terms used were: mobile, slaughterhouse, abattoir, dairy, cattle, cow, captive bolt, stunning, stun*, conscious*, load*, lame*, transport, fit for transport, bleeding, method, killing, slaughter, handling, animal, welfare. Terms with an * were automatically expanded in the search engine in various ways.
- Within Google Scholar, the terms 'mobile slaughter animal welfare, 'culling rate dairy cows', 'culling dairy cows netherlands', 'dairy cow lameness', 'fitness for transport', 'dairy cow lameness review' were used.
- A search was carried out in Google using the terms mobile slaughter unit animal welfare, reason for dairy cattle disposal, mobile slaughter, mobile schlachtanlage, and Mobile schlachteinheit.
- In addition, reference lists of retrieved literature were used, EFSA opinions were studied, WUR reports on previous red meat and dairy supply chain risk assessments were consulted and searched within the WUR edepot (using Google).

Food safety:

- The focus of the desk study into food safety hazards was on the delayed removal of the intestines (evisceration). To this end, a search was carried out on Scopus and Pubmed for scientific publications using the various combinations of the keywords 'cattle', 'delayed evisceration', 'food safety' and 'emergency slaughter'.
- In terms of the microbiological risks associated with the slaughter of cattle, reference was made to the EFSA opinion *Scientific Opinion on the public health hazards to be covered by inspection of meat (bovine animals)* from 2013, the Red Meat Supply Chain Risk Assessment conducted by BuRO in 2015 and the State of Zoonoses 2018 of the RIVM and the NVWA.
- Furthermore, a targeted search was carried out on Google for information on the normal body temperature of cows and use was made of the knowledge in the field of veterinary public health available at BuRO.

Animal health.

- A search was carried out for scientific publications on Scopus using various combinations of the keywords 'transport vehicle', 'vehicle borne', 'vehicle borne transmission', 'between farm transmission', 'farm-to-farm' disease and infection.
- In addition, the same search terms were used to search for grey literature on Google.
- The recent Monitoring reports of GD Animal Health (GD) were used in relation to the occurrence of certain animal diseases among cows in the Netherlands.
- The information available on the GD Animal Health website was used in relation to descriptions of the symptoms of certain animal diseases in cattle. Finally, there was use of the knowledge available at BuRO on animal health.

2.3. Data analysis by BuRO's Intelligence and Research department
In order to gain insight into the regular dairy cattle cull flows (transport to slaughter, to another farm, emergency slaughter and euthanasia), the department of Intelligence & Research at BuRO carried out a data analysis. The principal key figures of the MSU target population were requested for the purposes of this analysis, using the I&R (Identification & Registration) database and data from the Slaughter data on red meat (RSG database).

2.4. Execution of study by BuRO
BuRO first and foremost relied on the information available, which was obtained from the participants to the core group and which consisted of documents and emails. Furthermore, BuRO conducted a brief desk study into risks identified by the team from the Inspection and Enforcement directorates in relation to the operation of the MSU as well as into any other risks.

Based on the existing information, BuRO drew up a draft procedure outlining all the steps of the MSU, with a view to constructing a picture of daily practice that was as accurate as possible. The draft was initially assessed in consultation with one of the coordinating NVWA veterinarians (TDAs) and by two BuRO employees thereafter during a visit to the MSU on November 14, 2019.

In parallel, BuRO submitted a request to the core group (consultation of November 5, 2019) for it to provide additional information and for an additional fact-finding process for forthcoming inspections.

<u>2.4.1. Details of BuRO information request</u>

- Information from the previous period, such as VKI forms, withdrawal notes from period after July 2019, results of hygiene analysis carried out in January 2019.
- Request for information to be collected for a limited period:
  - through the AM inspection of newly supplied animals
  - through a number of random , unannounced, joint inspections carried out by inspectors from Enforcement and Inspection
  - through a number of unannounced, random controls for residues of veterinary medicinal products, specified as antimicrobials, corticosteroids and analgesics
- request to visit the MSU in order to carry out observations in particular with regard to procedure and critical points in relation to animal welfare, food safety and animal health.
- BuRO provided a draft checklist for the purpose of collecting additional information from AM inspections and joint inspections (Annex 3).

At the start of November 2019, BuRO received the information from the previous period as outlined in the above, such as the withdrawal notes from July to October 2019, and agreements were made for a visit to the MSU and employees of the Enforcement and Inspection directorates scheduled random inspections and controls. The visit to the MSU took place on November 14, 2019. The joint inspections carried out by inspectors from the Enforcement directorate and by veterinarians from the Inspection directorate were carried out on 3, 10, 12, 19 and 20 December 2019.

Throughout the additional information gathering process in November-December 2019, a data analysis was carried out of the MSU target population, i.e. the dairy cattle population in the Netherlands, the northern Netherlands region and the farms supplying to the MSU from the pilot. Potentially useful information from inspections at conventional slaughterhouses for possible high-risk groups of animals is used to identify aspects such as the number of animals that are offered for emergency slaughter. Data from the MSU pilot, which was collected between December 2018 and December 20, 2019, was used for this report.

Finally, a consultation took place on January 7, 2020 between two BuRO project team members and relevant participants in the organisation and execution of the joint inspections in the city of Zwolle for the purpose of hearing and sharing first-hand experiences of the inspections. During that conversation, which took place in an open and constructive atmosphere, BuRO enquired about the experiences in relation to the joint inspections. The most important remarks made during the meeting are listed in Annex 4.

2.4.2. Scenarios compared

Two scenarios have been compared and the differences between the two have been identified:
1. MSU scenario: use of the mobile slaughter unit (MSU), or
2. Non-MSU scenario: no use of the MSU.

Within the MSU scenario for dairy cattle the following 4 distinct phases can be identified:
A. before MSU registration,
B. after MSU registration,
C. MSU attends on site, and
D. after MSU (animal left behind alive)

Within the non-MSU scenario (i.e. current conditions under the law), 4 (emergency slaughter) or 6 (transport) phases can be identified:
A. before registration for transport or emergency slaughter,
B. after registration for transport or emergency slaughter,
C. transporter or emergency slaughter attends on site,
D. after transporter or emergency slaughter (live animal occasionally left behind if not admitted for emergency slaughter or transport)
E. transport takes place, and
F. arrival at slaughterhouse.

The scenarios are compared in Chapter 3 'MSU procedure and routine practice' after which the scenarios are outlined in greater detail.

2.5. Chronological outline of the overall MSU pilot according to key points:

Date	Event
September 2018	Verbal announcement of the MSU pilot in the House of Representatives
October 2018	Approval request for pilot submitted to NVWA Inspection directorate
9 November 2018	Report of MSU Ministry of Agriculture, Nature and Food Quality Letter to Parliament
December 2018	Kickoff of MSU pilot – 1st version of working protocol + working arrangements for supervising veterinarians
January 2019	Assessment of 1st 73 animals supplied, calibration of working protocol
March – April 2019	Participation of two Enforcement inspectors in pilot; with access to documents and option of several working visits to MSU in practice
January – July 2019	2nd part of the pilot with interim periodic consultations of executive veterinarians aimed at issues such as uniformity of

Date	Event
	working methods and adjustment of methods where necessary.
July 2019	Analysis of MSU pilot by Inspection directorate, including an overview of the principal reasons for culling to MSU, % of animals that are denied access to slaughter, and % of animals that are ultimately rejected for human consumption at the PM inspection
July – September 2019	Three joint meetings of Enforcement and Inspection directorates aimed at drafting a joint evaluation of the pilot
End of September 2019	Request from the Director of Strategy to BuRO for an objective, independent assessment of the risks to animal welfare, animal health and food safety
End of October 2019	BuRO action plan approved and core team assembled
November 5, 2019	Request for additional information, including through random controls
November 14, 2019	BuRO visit to MSU and Slachthuis Dokkum slaughterhouse
December 2 - 20, 2019	Execution of additional inspections and sampling for residue analysis
December 20, 2019 to January 2020	Processing of all data of MSU pilot between December 2018 and 20 December 2019 for BuRO opinion
January 7, 2020	Meeting hosted by BuRO with relevant parties, including inspectors and supervising veterinarians who carried out the joint inspections.

2.6. BuRO team visit to the MSU

On November 14, 2019, 2 BuRO employees with expertise in the field of animal welfare, animal health and food safety conducted a working visit to the MSU and the slaughterhouse in Dokkum (‘Slachthuis Dokkum’), the operator of the MSU. Their primary objective was to monitor and check the pre-defined process description of the activities (please see Annex 5a and 5b) carried out by the supervising veterinarians, the MSU employee and of the technical facilities. The BuRO team attended the activities at two farms, during which process a total of 4 animals were supplied for AM inspection, stunning, killing and transport in the MSU. They were able to review all activities in relation to the MSU, which were carried out in accordance with the protocols. The supervising veterinarian who carries out the AM inspection also verifies that the animal has been stunned correctly, if necessary by checking the cornea reflex.

The team were struck by the time pressure on the MSU process as a result of the tight schedule, with the supervising veterinarians required to complete various forms, including for the pilot. During the visit to the Slachthuis Dokkum, they were also informed of the registration procedure of the slaughterhouse, which includes an intake interview by phone to obtain more information regarding the animal’s background and where appropriate to advise for or against use of the MSU, in part due to the limited capacity in situations involving acute accidents which are eligible for emergency slaughter or deferral if animals are not (yet) deemed fit for slaughter due to waiting periods and/or fever.

3. **Background information**

Office for Risk Assessment & Research

Date
25 February 2020

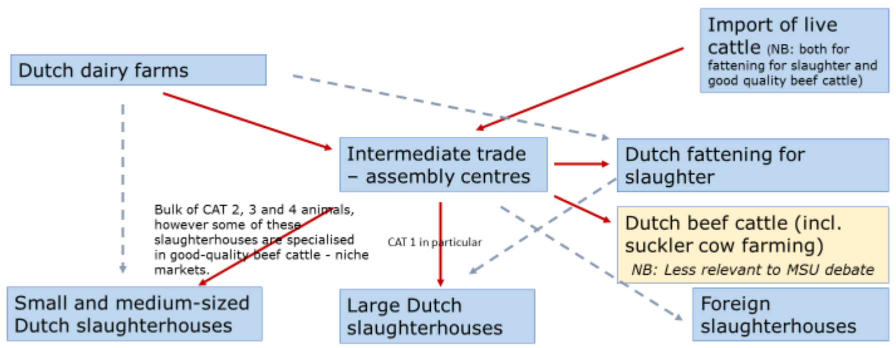
Our reference
TRCVWA/2020/1172

3.1. Potential use of the MSU in the red meat chain

The majority of annual culling in the dairy farming sector (cull dairy cattle) are expected to be in sufficiently good condition, and thus meaning they will be fit for transport and slaughter, based on the reason for culling. It is estimated that in 10-20% of cull cases, particularly in relation to any animals that are lame, more or less sick or have had an accident, it will not always be able to be determined objectively whether the animals are fit for slaughter and transport. Farmers face the choice of treating animals in the expectation of their regaining their health, however, at a certain juncture will make the decision to cull or have the animals culled or euthanised. The likelihood of recovery, the possibility of creating added value by selling or slaughtering animals (with the possibility of net profit), the costs of euthanasia (veterinary costs) and the costs of transport to Rendac are all factors in play in relation to that decision. In the case of selling live animals or selling animals for slaughter, the seller, trader or transporter runs a (low) risk of control during transport, at arrival at a slaughterhouse or assembly centre.

The MSU may generate added value for the category of animals that are not or may not be entirely fit for transport, but most likely are fit for slaughter.

In 2019, the majority of cull dairy cattle are transported directly to the slaughterhouse, whether or not through traders, with a small percentage being transported to another livestock farm or transported abroad. The major Dutch slaughterhouses generally focus on the higher quality animals, with a percentage of the smaller and medium-sized slaughterhouses being specialised in the processing of lower quality cull dairy cattle and/or emergency slaughter. The potential animal flows are shown in Figure 1, with the actual numbers of animals in 2019 being outlined in Table 5.



Monitoring (by NVWA) of fitness for transport takes place prior to international transport due to certification. At large slaughterhouses with permanent oversight, animal welfare is monitored during the AM inspection, preferably when cattle is being unloaded at which point 'unfitness for transport' is more easily identifiable than at the AM inspection at small and medium-sized slaughterhouses, which takes place 'on call' when all animals are already waiting in the holding pens at the slaughterhouse. Monitoring of (fitness for) transport in domestic transport or at assembly centres takes place on a random basis.

Figure 1. Potentially disposal routes for cull dairy cattle in the Dutch dairy farming sector

3.2. Examples of MSU and MS in other countries
In addition to the Netherlands, mobile slaughter units (MSU) or mobile slaughterhouses (MS) also operate in other countries. In a mobile slaughter unit (MSU) as used in the Netherlands, the animal is killed inside the MSU (or on the farm) and bled, after which the carcass is transported to the slaughterhouse for further processing. In a mobile slaughterhouse (MS), the animal is killed inside the MS (or on the farm) and bled and the carcass is the processed and chilled inside the unit. In practice, or in colloquial terms, MSUs are often referred to as mobile slaughterhouses. On its website, for example, Slachthuis Dokkum refers to the MSU as a mobile slaughterhouse. This evaluation uses the definitions for the MSU or the MS listed above, regardless of the term used by the operator.

In global terms, MSUs and MSs operate in various countries. A number of examples of which are outlined below. Mobile slaughterhouses have been operating in the United States for a long time (USDA, 2017). Sweden has also been operating an MS for several years, however, this initiative recently went into administration (Hultgren et al., 2018; ATL, 2019). In addition, several mobile slaughterhouses operate in Germany (Die Landforscher, 2019). There are also a number of new initiatives (such as 'Extrawurst' in Hessen and 'Schlachtung mit achtung') with a mobile slaughter unit in Germany, Switzerland and Austria, in which animals are inspected by an official veterinarian after which they are stunned in a stun box with head fixation and bled inside the vehicle. Animals must be bled within 60 seconds of stunning. In Germany and Switzerland, transport to the slaughterhouse may not take longer than 45 minutes, given that carcasses must be processed further at the slaughterhouse within one hour after killing. In Austria, carcasses must be transported to the slaughterhouse within an hour (SWR, 2018; Bundesinformationszentrum Landwirtschaft, 2019; Die Landforscher, 2019; Jakob & Zweifel, 2019; Steiermark, 2019). In November 2019, the German 'Schlachtung mit achtung' project received the Baden-Württemberg Animal Welfare award (topagraronline, 2019). A pilot initiative with a mobile slaughterhouse is currently also underway in France[5].

[5]https://www.legifrance.gouv.fr/eli/loi/2018/10/30/AGRX1736303L/jo/texte#JORFARTI000037548032https://www.legifrance.gouv.fr/eli/loi/2018/10/30/AGRX1736303L/jo/texte#JORFARTI000037548032

An overview of the various foreign initiatives and a comparison with the situation in the Netherlands shown in the table below:

Table 1. MSU Netherlands comparison with other European examples

Country	Type of animal	Stunning site	Stun box (head fixation)	Time to bleeding	Supervision	Max. time to carcass transport
MSU pilot Netherlands	Animals unfit for transport	Inside MSU (or outside MSU)	None (hand-held rope halter)	ASAP	Official veteri-narian (TDA, NVWA)	2 hour target deadline
Germany	Beef cattle	Outside MSU	Stun box (head fixation)	60 secs.	Official veteri-narian	45 mins
Switzerland	Beef cattle	Outside MSU	Stun box (head fixation)	60 secs.	Official veteri-narian	45 mins
Austria	Beef cattle	Outside MSU	Stun box (head fixation)	60 secs.	Official veteri-narian	60 mins
Sweden	Beef cattle	Outside MSU	Stun box (head fixation)	120 sec. bench mark	Official veteri-narian	N/A

The key differences between the MSU pilot in the Netherlands and the aforementioned examples abroad are:

- Target group is cattle unfit for transport instead of beef cattle (primarily in a short chain niche market),
- Animals are in principle required to enter the vehicle,
- No use of a stun box with head fixation,
- No maximum time between stunning and bleeding under Dutch law,
- No maximum time between bleeding and arrival of carcass at slaughterhouse. The instructions were to ensure alignment with emergency slaughter protocol: carcasses must be chilled if procedure takes longer than 2 hours.

3.3. MSU method and normal practice – scenario comparison

Once a dairy cow develops a condition the latter can either be categorised as acute or chronic (Figure 2). An acute condition is defined by a seemingly spontaneous condition, such as a broken leg as a result of a slip and fall. A chronic condition involves a longer period of time and is persistent, such as lameness as a result of osteoarthritis.

Acute condition: Animals with an acute condition may not be fit for transport under the Animal Transport Regulation (Regulation (EC) 1/2005)[6], however may become fit for transport again if the condition is temporary, either with or without (veterinary) treatment.

Article 3 of the Animal Transport Regulation (Regulation (EC) 1/2005) sets out the general requirements for the transport of animals: 'No person shall transport animals or cause animals to be transported in a way likely to cause injury or undue suffering to them.'

Annex I, Chapter I, point 2: '*Animals that are injured or that present physiological weaknesses or pathological processes shall not be considered fit for transport and in particular if*
1. *they are unable to move independently without pain or to walk unassisted;*
2. *they present a severe open wound, or prolapse*
3. *they are pregnant females for whom 90 % or more of the expected gestation period has already passed, or females who have given birth in the previous week.'* (NVWA, 2017)

Cattle with an acute condition that is not given further treatment will be supplied for emergency slaughter or will be euthanised on the farm. Emergency slaughter is subject to various requirements under Regulation (EC) 853/2004[7](NVWA, 2017):
1. The animal must have suffered an accident (such as a bone fracture, severe open wound, birth defect)
2. The animal must be healthy at the time of the accident (no disease and absence of veterinary medicinal products)
3. The animal must be unfit for transport for welfare reasons

There must be a causal link between the accident and the injury (maximum time between accident and time of killing is three times 24 hours)(NVWA, 2017).

The practicing veterinarian conducts the AM inspection. The animal is stunned and bled on the farm. The carcass must be transported to the slaughterhouse as soon as possible. The carcass must be chilled if this does not take place within 2 hours (NVWA, 2017).

Following emergency slaughter, the animal enters the food chain provided it has been approved – otherwise it must still be transported to Rendac. If emergency slaughter is not permitted, the animal must be euthanised on the farm and subsequently must be transported to Rendac (please see paragraph '3.3.2. Standard practice – scenario without MSU'). In this case, the MSU could be used if the animal's meat were otherwise suitable for human consumption (Figure 2) (please see paragraph '3.3.1. MSU method – MSU scenario'). In this case, the animal would still enter the food chain, provided it were otherwise suitable for human consumption – if not, it would still have to be transported to Rendac and/or transported to the processor of animal by-products category 3 or 2[8].

Chronic condition: Animals with a chronic condition, like those with an acute condition, may not be suitable for transport. However, similarly, they may become suitable for transport again if the condition is temporary in nature, with or without

[6]Council Regulation (EC) No 1/2005 of 22 December 2004 on the protection of animals during transport and related operations and amending Directives 64/432/EEC and 93/119/EC and Regulation (EC) No 1255/97. Document 32005R0001. http://data.europa.eu/eli/reg/2005/1/oj.
[7]Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for food of animal origin
[8]For an explanatory note on the three categories of animal by-products, please see: https://www.nvwa.nl/onderwerpen/dierlijke-bijproducten/de-3-categorieen-dierlijke-bijproducten

(veterinary) treatment. However, under the Animal Transport Regulation (Regulation (EC) 1/2005) animals with a chronic condition may also be suitable for transport with such a condition. Where:

Annex I, Chapter I, point 3 of the Animal Transport Regulation (Regulation (EC) 1/2005) states: *'However, sick or injured animals may be considered fit for transport if they are: a) slightly injured or ill and transport would not cause additional suffering; …'*

When assessing the fitness for transport of borderline cases, a number of issues must be taken into account, such as the animal's overall condition, the length and conditions of transport, the question of whether the animal's condition will deteriorate during transport and the risk of the animal being rejected at the slaughterhouse (Eurogroup for Animals et al., 2012). Examples of borderline cases that require additional attention include animals that have trouble moving, animals with (open) wounds and swelling. These are merely examples and the overall condition of the animal must be reviewed on a case-by-case basis. Annex 6 sets out detailed examples of animals that are fit for transport, unfit for transport and that are fit for transport subject to certain requirements.

Cattle that have been deemed fit for transport are subsequently transported, usually directly to slaughter. The cattle then enter the food chain for human or animal consumption or, if they are deemed wholly unfit for human consumption, they are transported to Rendac for further processing (= rendering plant).

Potentially unauthorised routing/'high-risk group' standard transport to slaughter:
It is (theoretically) possible for cattle suffering from a condition – either inadvertently or deliberately – to take the incorrect route to Rendac or the food chain. This is only the case for the group of animals that is de facto not fit enough for transport. These animals may 1) be supplied for transport anyway and be accepted by the transport and subsequently slaughtered according standard procedure (please see '*BuRO advice on the risks associated with the use of paracetamol in cattle*'), 2) supplied and accepted for emergency slaughter while being unsuitable, or 3) if the MSU is operational, they could be transported alive using the MSU.

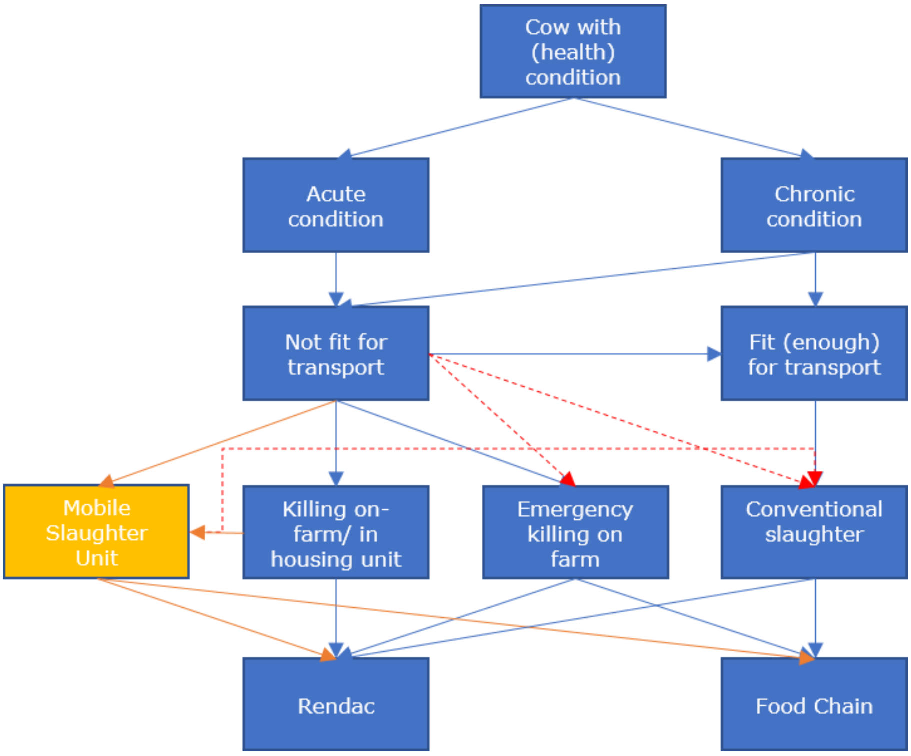


Figure 2. The key points of the pathway of cows with an acute or chronic condition for disposal through Rendac or supply to the food chain. The pathway in accordance with the current legal framework (scenario without the MSU) is marked in blue, the pathway using the Mobile Slaughter Unit (MSU scenario) is shown in yellow, the red arrow with dotted line indicated potentially unauthorised routing. NB Emergency slaughter de facto also involves killing on the farm/in the housing unit, with the difference that emergency slaughter should always involve animals with an acute condition! As such, chronically ill animals will not end up at emergency slaughter but will be able to be supplied to the MSU, where they would otherwise have to be killed in the housing unit if they were not fit enough for transport.

3.3.1. MSU procedure – MSU scenario

Prior to the start of the pilot, a working protocol for the MSU was drafted by the Inspection directorate and a team of executive supervising veterinarians (TDAs) was put together that would principally carry out the AM inspections of the animals supplied. The point of departure was to gain experience with the MSU on the job in a practical setting.

The pilot was kicked off in mid-December 2018 with an initial cohort of 50 to 100 animals, where aspects such as the PM inspection were carried out by the supervising veterinarian for this initial period. During the pilot, the team of executive veterinarians periodically consulted with their project leader to exchange experiences and to calibrate protocols if necessary. Following an interim evaluation of the first 73 animals that were supplied between December 13, 2018 and January 4, 2019, a decision was taken in mid-January that standard PM inspections would no longer have to be carried out by the supervising veterinarians but that periodic inspection by KDS would suffice. Furthermore, the protocol was adjusted in a number of areas in the interim.

If transport and emergency slaughter are not permitted, the animal must be euthanised on the farm and subsequently must be transported to Rendac (please see paragraph 3.3.2. 'Standard practice – scenario without MSU'). In this case, the MSU could be used if the animal's meat were otherwise suitable for human consumption (Figure 2). Following emergency slaughter, the animal would then still enter the food chain provided it had been approved – otherwise it would still have to be transported to Rendac.

In summary, the MSU procedure consists of the following steps (please see Annexes 5a and 5b for a detailed outline):

1. Livestock farmer registers animal for MSU at slaughterhouse
2. Slachthuis Dokkum carries out an intake registration interview by phone and determines which animals are to be permitted access to the MSU.
3. Slachthuis Dokkum draws up schedule for the MSU route and requests AM inspection at NVWA
4. MSU and supervising veterinarian attend livestock farm
5. Supervising veterinarian carries out AM inspection
6. MSU employee stuns and bleeds the animal
7. Carcass is transported to the slaughterhouse
8. Further processing at the slaughterhouse

As previously shown, the MSU is an extension or a part of a conventional slaughterhouse, in which the AM inspection, stunning, killing and bleeding of the animal takes place outside 'the physical slaughterhouse' and where the dead animal is transported to the slaughterhouse for slaughter in a vehicle specifically designed for that purpose. The associated registration procedure, which involves an intake process to determine whether an animal is or is not eligible for the MSU, is also different component. Another specific aspect is that the supervising veterinarian is also continuously present, i.e. after having carried out the AM inspection, he or she will also be present at the stunning and killing of the animal, during which he or she will supervise the process. Transport to the slaughterhouse takes place outside of the oversight of the NVWA and at the slaughterhouse standard inspection is carried out by the KDS, unless there are indications at the AM inspection that the PM inspection must be carried out by an official veterinarian ('officiële dierenarts', OD = TDA, NVWA).

Experience shows that the scheduling of the activities of the MSU is adapted during the day, among other things because animals are added in the interim, which are eligible for emergency slaughter, and because animals that have been registered are rejected because they are not free of fever when being checked in advance by the owner.

3.3.2. Standard practice: euthanasia, emergency slaughter, 'high-risk group' standard transport to slaughter – scenario without MSU

In this instance, the key issue is the comparison of the same group of animals that are supplied to the MSU, i.e. with the same diseases.

In fact, the non-MSU scenario consists of 3 sub-groups (Figure 2):

- If emergency slaughter is not permitted (chronic condition), the animal will be euthanised/killed on the farm and transported to Rendac.
- If the animal has had an accident (acute condition), the animal will enter the emergency slaughter process within three days.
- The animal will be placed on standard transport to the slaughterhouse, whether or not with an intermediate stopover at the assembly centre. This group will

immediately be referred to as a 'high-risk group', given that animals that are suited for the MSU are in fact not fit for standard transport.

In the scenario in which the sector does not have an MSU (de facto the current legal conditions), 1 (euthanasia or no action), 4 (emergency slaughter) or 6 (transport) stages can be distinguished:

A. No or prior registration for transport or emergency slaughter,
B. after registration for transport or emergency slaughter,
C. transporter or emergency slaughter attends on site,
D. after transporter or emergency slaughter (living animal left behind),
E. transport takes place, and
F. arrival at slaughterhouse.

3.3.3. Additional information on fitness for transport of dairy cattle culled to slaughterhouse

The key reasons to cull dairy cattle are reduced fertility, udder health/mastitis, lameness, low production and accidents (please see paragraph 4.2. Replacement of dairy cattle). Animals that have had an accident are eligible for emergency slaughter and thus will not be transported to the slaughterhouse alive. Reduced fertility, udder health and low production (depending on the further condition of the animal) are not a reason to judge the animal to be unfit for transport. Animals which are culled due to lameness are unfit for transport if they cannot move without pain, cannot support themselves on four legs, cannot walk or lie down unaided (Eurogroup for Animals et al., 2012; Consortium of the Animal Transport Guides Project, 2017).

Dahl-Pedersen et al. (2018b) carried out a study in Denmark on the fitness for transport of cull dairy cows which were transported to the slaughterhouse. The condition of 411 cull dairy cows was assessed prior to their transport to the slaughterhouse. The animals were clinically evaluated on a number of issues, including physical condition, coat condition, injuries and locomotion score. In total, 75% of the animals had at least one deviation from the normal standard for the various clinical assessments. 31% of the animals were lame (locomotion score of 3 or above), 20% presented with signs of mastitis and 22% had injuries (not severe). Only a few animals were assessed as unfit for transport, however many of the animals could be described as 'slightly injured or sick animals'. In the follow-up study carried out by Dahl-Pedersen et al. (2018a), the culled animals were assessed again upon arrival at the slaughterhouse. Nine of the 411 transported dairy cows were assessed as 'unfit for transport' upon arrival at the slaughterhouse. These animals were lame (locomotion score of 3 or 4) upon departure from the farm and were assessed as severely lame (score of 5) upon arrival. The degree of lameness similarly increased in other animals. Upon arrival at the slaughterhouse, 41% of the animals was lame compared to 31% upon departure from the farm. Even in the case of cows that were not lame (score of 1 or 2) at the start of transport, 15.8% was lame on arrival at the slaughterhouse. In addition, the percentage of cows with milk leakage and cows with injuries on arrival at the slaughterhouse increased. These results show that transport is a burden to cull dairy cattle (Dahl-Pedersen et al., 2018a). In this case, transport for these animals has caused 'additional suffering'.

4. Data analysis

The data analysis was carried out using I&R data and data from the agricultural census in order to get a picture of the dairy farms in the Netherlands, northern Netherlands (Groningen, Friesland and Drenthe) and the farms that took part in the MSU pilot. The operating area of the MSU in the pilot is the region of team VKE-02 North, which is Friesland, Groningen and part of Drenthe. The data analysis is based on the provinces of Friesland, Groningen and Drenthe. This chapter will compare the findings of the data analysis between the regions and will compare them with the findings in the literature. The table below shows an overview of the findings.

Table 2. Key figures of dairy farms in the Netherlands, northern Netherlands and MSU participants based on I&R 2019 and agricultural census

	The Netherlands	Northern Netherlands	MSU participants
# dairy farms (BRS)	16,241	4,372	922[9]
# animals > present 2 years ***Reference date 01/01/2019***	1,608,550	517,804	133,461
Avg. dairy farm size (# animals > 2 years)	100	119	146
# animals > 2 years cull to slaughter	290,578	92,296	26,817[10]
% animals to slaughter > 2 years	18%	18%	20%
# animals slaughtered through MSU		1934	1934
% slaughtered through MSU		2%	7%
# animals > 2 years deregistered with code for natural death	63,657	22,893	6,366
% natural death > 2 years	4%	4%	5%
# cull > 2 years (not being slaughter, incl. export)	101,225	20,543	7,172
# animals > 2 years export	16,332[11]	5,563	1,179
# cull > 2 years (not being slaughter, incl. export)	6%	6%	5%
Total replacement percentage > 2 years (natural death, cull and slaughter)	27.8%	27.7%	30.2%
Avg. age of culled animals (> 2 years) (natural death, slaughter, cull)	5.1 years	5.2 years	5.2 years

4.1. Farm size

In 2019, there were approximately 1.6 million dairy cows in the Netherlands, held at a total of approximately 16,000 dairy farms. Farms in the northern Netherlands

[9] The 922 farms that supplied animals to the MSU relate to the overwhelming majority of dairy farms, however also include other cattle farmers.

[10] This is the MSU data period from December 2018 to December 20, 2019.

[11] This is largely to Belgium and Germany; according to Traces, in 2019 16,014 animals were certified with the destination of export for slaughter in Belgium and Germany.

are larger (average of 119 cows) than the average farm in the Netherlands (100 dairy cows). The farms that participated in the MSU pilot were on average even larger, holding 146 dairy cows. Apart from the farm size, there were no notable differences in the key figures between MSU farms and farms in the Netherlands as a whole or in the northern Netherlands.

4.2. Replacement of dairy cattle

4.2.1. Annual cull of dairy cattle

Each year, dairy farmers will replace part of their herd. There is significant variation between the various farms in terms of replacement rates (Orpin & Esslemont, 2010; Nor et al., 2014; Haine et al., 2017). In international terms, the percentage of replacement in dairy farming varies between 22.7% and 33.7% (Bell et al., 2010; Orpin & Esslemont, 2010; Pinedo et al., 2010; Chiumia et al., 2013; Alvåsen et al., 2014; Nor et al., 2014; Haine et al., 2017).

In a Dutch study conducted at 1903 dairy farms between 2007 and 2010, the cull rate was 25.4% (Nor et al., 2014). KWIN 2019-2020 sets the standard for culling of the average number of dairy cows present at 28% (Blanken et al., 2019). A data analysis of the Dutch dairy cattle population is regularly carried out by GD Animal Health (GD) as part of its basic monitoring and GD Animal Health has calculated the annual replacement percentage to be 28.6% in the period between October 2017 and September 2018. The average lifespan of a dairy cow is 5.7 years (Gezondheidsdienst voor Dieren, 2019a).

The total replacement rate on MSU farms is slightly higher than the average replacement rate in the Netherlands in 2019 (27.8%) with 30.2%. However, both the replacement rate of the MSU farms and the average replacement rate in the Netherlands in 2019 are similar to the findings in the literature.

4.2.2. Reasons for culling cattle

Dairy cattle is replaced for various reasons. There is no obligation to document the reason for culling cattle in the Netherlands or in other countries. Upon enquiry at GD Animal Health and the Faculty of Veterinary Medicine, there seemed to be no recent overview of the reasons for culling cattle. BuRO's own literature review shows that the main reasons for the culling of dairy cattle worldwide (in the Western world) are: fertility (19-36%), udder health (7-30%), lameness (6-16%), low productivity (5-15%) and accidents (Orpin & Esslemont, 2010; Pinedo et al., 2010; Ahlman et al., 2011; Boer et al., 2013; Chiumia et al., 2013; Alvåsen et al., 2014; Kerslake et al., 2018).

A study by Boer et al. (2013) conducted among 87,000 dairy cows that were culled in the Netherlands, fertility (19%), mastitis (18%), lameness (15%), low production (5%) and old age (4%) emerged as the principal reasons for culling animals (cited by the farmer at CRV).

4.3.2. Culling cattle through the MSU

A total of 922 farms took part in the MSU pilot, which amounts to 21% of the dairy farms in the northern Netherlands region. In total 7% of the animals slaughtered by the MSU farms were supplied and slaughtered through the MSU. For the northern Netherlands, this was 2% of the animals > 2 years of age slaughtered.

Animals that are culled for reasons of fertility, udder health and/or a low level of productivity are generally in a good condition and have a low risk of being unfit for transport or slaughter (suitable for human consumption). These animals will be culled to the slaughterhouse through the usual channel. The category of animals that is culled for reasons of lameness, injury due to accidents and/or disease have a relatively high risk of reduced fitness for transport. These animals are eligible for slaughter through the MSU (and/or emergency slaughter).

Between 13/12/2018 and 1/11/2019, 10 days were randomly selected and the dossiers of the 115 animals supplied on those days were reviewed. The table below contains an overview of the reasons for the culling of animals through the MSU. In this sample, 87% of the animals that were supplied was lame, with claw disorders cited as the most common cause.

Table 3. Reason for cull through the MSU cited for the animals supplied on the 10 days of the sample.

Reason for MSU cull		Number of animals	% of total
Lame	Claw disorders	50	43%
	Hock injuries	6	5%
	Claw disorders and hock injuries	1	1%
	Hock injuries and other lameness	2	2%
	Claw disorders and other lameness	3	3%
	Claw disorders and hock injuries and other lameness	1	1%
	Other lameness	37	32%
	Total lameness	**100**	**87%**
Other	Slip/accident	6	5%
	Downer	2	2%
	Other	7	6%
	Total	**115**	**100%**

According to the literature, the most common causes of lameness are sole bleeding and ulcers, white line defects, Mortellaro and interdigital necrobacillosis (Bell et al., 2009; EFSA AHAW Panel, 2009; Potterton et al., 2012). Claw diseases can be divided into non-infectious diseases affecting the claw horn and infectious diseases of the surrounding skin (EFSA AHAW Panel, 2009; Visser et al., 2015; Gezondheidsdienst voor Dieren, 2019b).

Lameness in dairy cattle is a common welfare problem (Bell et al., 2009; Potterton et al., 2012). Summarising several studies, in global terms, the prevalence of lameness in dairy herds is approximately 25% (Cook et al., 2016). In a study conducted in the Netherlands in 2003 on 19 dairy farms (1450 cows) an average of 16.5% of cows were lame (locomotion score of 4 or 5) (Amory et al., 2006).

The table below sets out the reasons for culling cattle indicated by the international literature, across the Netherlands and in relation to the animals supplied to the MSU for comparison. Only a number of lame animals, probably the serious forms that are certainly not fit for transport, are culled through the MSU. The other animals will therefore be culled through another channel (the majority being culled through standard transport to slaughter).

Table 4. Comparison of reasons to cull animals – globally, the Netherlands and MSU animals.

Dairy cattle replacement reason	Global	The Netherlands (Boer et al. (2013), CRV data)	MSU animals Northern Netherlands (sample of 110 animals)
Fertility	19-36%	19%	
Udder health	7-30%	18%	
Lameness	6-16%	15%	87%
Productivity	5-15%	5%	
Accidents			5%
Old age		4%	
Other	10-20%	39%	8%

Between December 2018 and the start of September 2019, additional reports were drawn up by the supervising veterinarians in relation to the animals supplied to the MSU (data of 759 animals). These reports show that 5% of the animals that were supplied would also have been eligible for emergency slaughter.

4.2.4. Summary overview of culling routes per reason of replacement

The figures above and the reasons for culling cattle are summarised in the table below. The potential for use of the MSU has also been indicated for each culling route. The table is combination of various figures and some figures are a rough estimate. As such, the table provides indications rather than exact figures.

Table 5. Size of culling routes for dairy cattle > 2 years estimated by BuRO

Category	% compared to dairy cattle > 2 years	Estimated size	Source of data	Culling cattle through	MSU option?
Mortality	4%	63,657	I&R 2019		
Natural death		Approx. 50,000		Rendac	No
Euthanasia		Approx. 13,000	Veterinarian personal communication (rough estimate)	Rendac	If suitable for consumption
Cull to slaughter	18%	290,578	I&R 2019		
Healthy animals fit for transport		> 200,000		Standard transport	
Accidents		Approx. 10,000	RSG data[12]	Emergency slaughter	MSU option
Transport of high-risk animals		>> 20,000	RDA report on sick and injured cattle RDA (2007), RSG data[13]	Standard transport	MSU option
Export		16,322	I&R 2019	Standard transport	

4.3. MSU target population

In 2007, the Council on Animal Affairs (RDA) published an opinion on sick and injured cattle ('wrak vee') in which the problems of a group of cull cattle are analysed and put into perspective, partly in view of the European animal transport regulation for live cattle that was introduced at the time (as of 5/1/2007). The Council defines sick and injured cattle as 'animals that are more than slightly injured or more than slightly ill' and concludes that 'downer animals are by definition unfit and therefore should not be transport.' The Council also states that the EU Hygiene Regulation of 1/1/2006 has once again given slaughterhouses the opportunity to receive and process sick and injured cattle, which is suitable for human consumption, under certain conditions. The Council states that in 2006 each year some 28,000 animals are supplied to special slaughter sites[14] of which some 10% are rejected at the PM inspection and as such could/should have been euthanised at the farm and transported directly for destruction.

[12] estimate based on RSG (Red Meat Slaughter Data) of category 4 animals, held at PM inspection

[13] estimate of number high-risk animals in standard transport based on an extrapolation of RDA report on sick and injured cattle of 2007 (28,000 animals) and data from the NVWA slaughter data for 2017-2019 on animals that were retained at slaughter.

[14]Prior to 2006, special slaughter sites were designated where weak and sick animals were slaughtered. Since the introduction of the hygiene regulations in 2006, these sites no longer exist.

4.3.1. Available information from NVWA Red Meat Slaughter data dossier

BuRO requested the slaughter data for the years 2017 to 2019 from the NVWA data files (RSG database) in order to gain insight in aspects such as the total number of cases of emergency slaughter in the Netherlands (please see Table 6). A key limitation in this case is the fact that the RSG is not intended for these types of analyses, but rather as a summary of slaughter data. In 2017 and 2018, between 9,000 and 10,000 cows were supplied for emergency slaughter each year. In addition, approximately 20,000 cows were supplied for slaughter each year, which were given provisional access to slaughter at the AM inspection and which were transferred to the supervising veterinarians by KDS employees at the PM inspection. It is expected that the vast majority of these cattle were from the dairy farming sector.

4.3.2 Estimate of target population from dairy farming for the MSU

Since the publication of the RDA's report in 2007, the number of dairy cattle over 2 years of age has increased from over 1.4 million in 2006 to 1.6 million in 2019. (source: www.agrimatie.nl). Based on both the increase in scale of dairy farming (relatively less time available per worker per animal) and a higher level of productivity, it seems likely that the size of the group of sick and injured cattle should have increased both in absolute numbers, but also as a percentage of dairy cattle over 2 years of age present. On the basis of these assumptions, BuRO estimates the potential target group for the MSU (sick and injured cattle) to be at least several tens of thousands of animals per year. *(This number is likely to increase as enforcement of fitness for transport is intensified).*

4.4. Dutch red meat slaughterhouses

In the Netherlands, as of 2019, there are over 200 slaughterhouses for red meat, of which 137 slaughter cattle (cattle older than 1 year; no veal calves). As of 2019, there are no longer any large red meat slaughterhouses in the northern Netherlands (with permanent NVWA supervision), with only small and medium-sized slaughterhouses remaining which are partly dedicated to less common slaughter and/or emergency slaughter.

The number of cattle slaughtered in the Netherlands on an annual basis has been declining since 2016 and amounted to over 460,000 animals in 2019.

Table 6. Numbers of cattle slaughtered between 2017-2019 including the number of animals 'held back' at the PM inspection for categories 2, 3 and 4.
(please see list of definitions and abbreviations for clarification of the categories)

year	total slaughtered	# animals held back in Cat 2	# animals held back in Cat 3	# animals held back in Cat 4
2017	644,419	17,904	1,215	9,802
2018	587,363	19,720	1,239	9,402
2019	467,184	tbd	tbd	tbd

4.5. Animals supplied to MSU

4.5.1. Number of animals supplied

In total, between 13/12/2018 and 20/12/2019 some 1934 animals were supplied to the MSU, the breakdown of which for the various months is shown in the chart below.

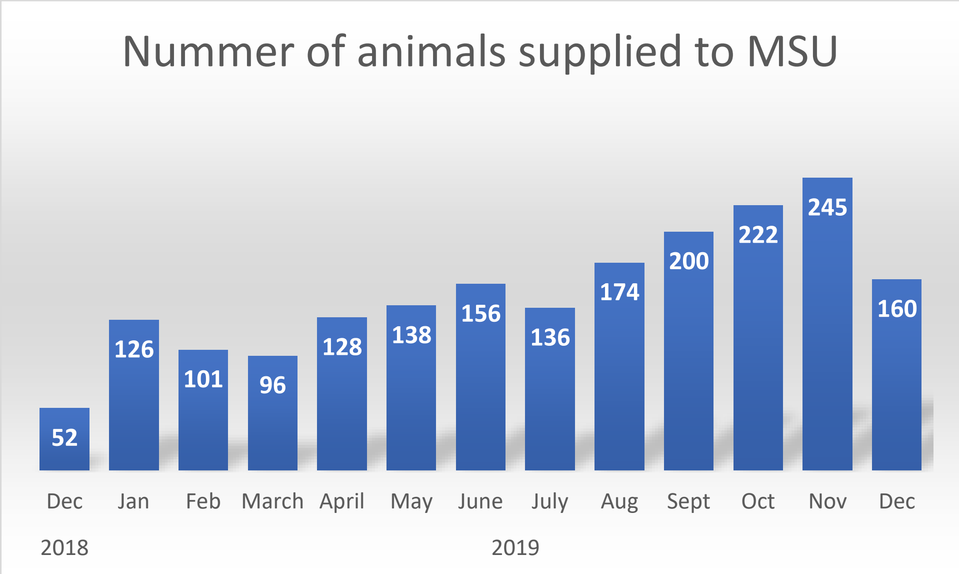


Figure 3. Number of animals supplied to MSU per month

Following the data analysis, the department of Intelligence & Research was able to link the animals supplied to 930 UBNs (Unique Establishment Number) in I&R, corresponding to 922 farms (BRS). Roughly a third of these UBNs supplied the MSU with 1 animal during this period, with approximately a quarter supplying 2 animals. One farm stands out with 80 animals supplied to the MSU. The average age of the animals slaughtered was 5.6 years old, with the oldest cow slaughtered being 18.2 years old.

<u>4.5.2. Access to slaughter</u>

Of the 1934 animals supplied to the MSU between 13/12/2018 and 20/12/2019, 1766 animals were admitted to slaughter following AM inspection. 11% of the animals was recumbent during the execution of the AM inspection. Following access to slaughter, 45 animals (2.4%) were subsequently excluded for human consumption ('uitgesloten voor menselijke consumptie', UHC) after the PM inspection. 168 animals (9%) were not given access to slaughter ('geweigerd tot slacht', GTS). 32 of these animals were then offered for slaughter through MSU again. 1 animal was offered for slaughter a third time after being denied access to slaughter twice.

93 of the animals that were denied access to slaughter were killed on the same day or the following day (death by natural causes reported in I&R). It cannot be determined from the data whether these animals were killed by an MSU employee or whether they were euthanised by the practising veterinarian on the same day. The analysis of the reports from December 2018 to September 2019 showed that 29% of the animals that were denied access to slaughter were killed on site by the MSU employee and were transported to Rendac. As such, however, a full picture cannot be provided.
15 of the animals denied access to slaughter are still alive according to I&R, 5 have been exported, with the other animals having been deregistered on I&R with a notification of death by natural causes longer than 2 days after having been offered to the MSU or supplied to the MSU again.

Figure 4. Breakdown of number of AM inspection decisions

4.5.3. Progression over time

The number of animals supplied per quarter increases and the percentage denied access to slaughter decreases.

Table 7. Number of animals supplied and denial of access to slaughter per quarter

Quarter	number of animals	number denied access to slaughter	% denied access to slaughter
2019 Q1	375	45	12%
2019 Q2	422	36	9%
2019 Q3	510	43	8%
2019 Q4	627	44	7%
Total	1934	168	9%

4.6. Preliminary results of the fact-finding process from 20 November to 20 December 2019

4.6.1. Random controls for residues of medicinal products

During the aforementioned period, on the instructions of the NVWA, the KDS took random, unannounced samples from three animals on 1 day each week for residue analysis according to the methodology of the National Residues Plan. In total, 39 samples (organs and meat) were collected from 15 animals and submitted to Wageningen Food Safety Research (WFSR) for analysis for residues of antibiotics, analgesics and corticosteroids.

The meat of 13 animals was analysed for analgesics. A very high concentration of paracetamol (3600 µg/kg) was found in one animal. Three samples presented positive with concentrations around 10-20 µg/kg. For two of these samples, paracetamol cross-contamination during the sampling at the slaughterhouse cannot be excluded.

4.6.2. Results of the joint inspections carried out by inspectors from the Enforcement directorate and by veterinarians from the Inspection directorate

Unannounced inspections were carried out for five days at the same time as the visit of the regular supervising veterinarian. A total of 38 farms were visited, with

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57 animals being supplied to the MSU. The checklist provided by BuRO was used as a guideline, including a specific request for the fitness for transport and locomotion score to be recorded as such. Other key components included verification of the accurate completion of the VKI forms and the joint assessment of the 'impression' given off by the cattle farm.

Some of the findings of the inspections are:
Of the 38 farms that were visited: 35 were dairy farms, 2 were rearing farms and 1 was a beef cattle farm. In total, 6 animals (10%) were not admitted to slaughter. These animals were all euthanised on site by the operator of the slaughterhouse.

The majority of the animals (44 = 77%) were offered due to lameness. In addition, 7 animals that were recumbent (including due to a difficult birth, an accident or nerve damage) were offered alongside 6 animals with different reasons.

Table 8. Assessment of lameness during the AM inspection of 57 animals at 38 farms

Locomotion scores		Number
1	Normal	5
2	Slightly lame	10
3	Moderately lame	12
4	Lame	17
5	Severely lame (recumbent)	6
	Not answered	7
Total		**57**

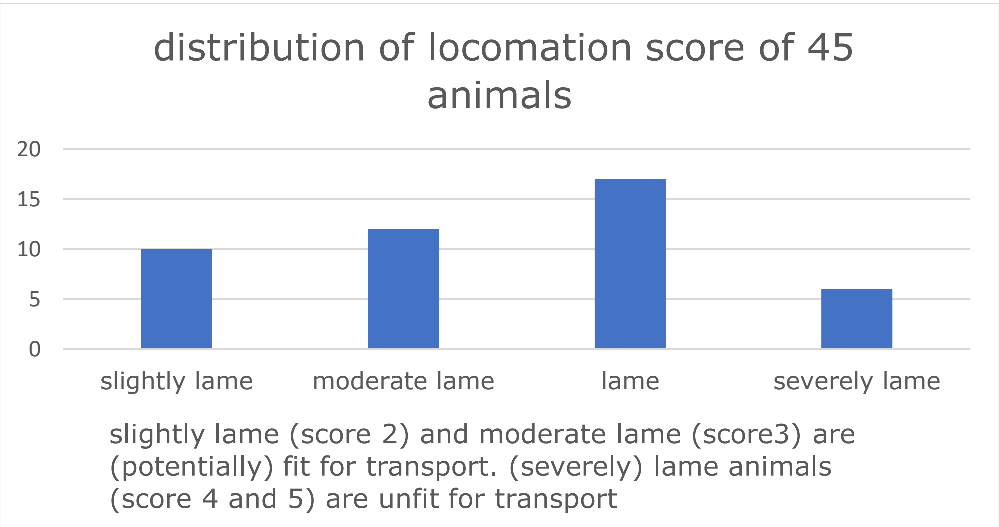

Figure 5. Frequency distribution of the locomotion score in the joint inspections.

Table 9. Assessment of the livestock farms during the joint inspections.

	Number of farms	Percentage
Good	27	71%
Satisfactory	4	11%
Poor	7	18%

5. Animal welfare risk assessment

This chapter will outline the risks to animal welfare based on the various stages that can be distinguished within the scenarios for comparison, i.e. with or without the MSU. The stages de facto comprise the pathway that an animal with a condition may take from the stage at which it is alive on a farm to its death. The chapter will start with a summary paragraph.

5.1 Summary

Animal welfare risks will arise throughout the entire slaughter process up to the animal's death, regardless of the methods that are used. The comparison of the two scenarios, 1) the MSU scenario and 2) the non-MSU scenario (= standard practice), shows that the animal welfare risks for animals suffering from a condition are reduced across the entire process if an MSU is used than in standard practice.

The most significant difference in terms of animal welfare risk is expected to lie in the prevention of a deterioration of the welfare condition of the animals with a disease (unfit for transport), as a result of the transport, unloading, waiting at the slaughterhouse and the remainder of the route to the slaughter site. Transport in particular is characterised as the principal stressor for these animals.

The standard practice scenario, without the MSU, is made up of three sub-groups: euthanasia, emergency slaughter or standard transport – whether or not with a stopover at an assembly centre or another farm – to slaughter. Transport is only permitted if animals are fit for transport: in principle, MSU animals are not. Emergency slaughter is only an option if an animal has had an accident and must take place within three days. As such, most animals suitable for the MSU would normally have to be killed by euthanasia. The group that is placed on routine transport (eventually to the slaughterhouse) is already a high-risk group, given that this is an unauthorised route if the animal is unfit for transport.

There are 6 distinct phases within the two scenarios:

A. on the farm before registration,
B. on the farm after registration,
C. arrival of slaughterer/euthaniser or transporter,
D. remaining on the farm alive,
E. standard transport,
F. routine slaughterhouse.

For each phase there may be differences between the scenario using the MSU and the non-MSU scenario in terms of practices, however there may also be differences between the sub-groups of emergency slaughter, euthanasia and routine transport to slaughter (please see Table 10.1).

Due to the differences in practices, differences in the risks to animal welfare are also expected both between the scenarios as well as within the sub-groups of the non-MSU scenario (Table 10.2). Please note that these are qualitative estimates based on informed reasoning.

Higher risks to animal welfare in relation to the MSU are associated with the AM inspection and in relation to the stunning and bleeding of animals (please see phases C for the MSU and F for conventional slaughter). At the AM inspections of the MSU, animals are examined critically, which is expected to result in more animals being denied access to slaughter and thus possibly being left behind alive (phase D). Refusal of access to slaughter, resulting in animals remaining at the farm due to the ante mortem inspection, in the scenario with the MSU may lead to higher risks to animal welfare, with existing distress caused to animals being unchanged. During the final weeks of the MDU pilot that were analysed, however, it became clear that no animal was left behind on the farm alive, but it is unclear as to whether this will be the case in the future. In relation to stunning and killing (phases C and F), there is a higher (but still a marginal!) risk that stunning and bleeding is not carried out adequately in the MSU due to space constraints combined with significant time pressure.

Lower risks to animal welfare in relation to the MSU are to be expected in terms of loading-walking to the vehicle (phase C), transport (phase E), stress prior to the slaughter process and (phases C and F) killing by an unqualified person (phases A and D). With regard to the loading process and entering the vehicle, not all MSU animals will have to undergo this process, as animals may be shot in the housing unit or in front of the loading flap. MSU animals are not transported alive and therefore no longer need to be unloaded at the slaughterhouse. The total amount of stress to an animal killed in the MSU is more limited compared to that of routine transport and slaughter at the slaughterhouse. The MSU prevents the potential killing of dairy cattle by less experienced or less skilled persons, e.g. if they have not had relevant training (killing by someone other than the practising veterinarian) or if this is not routine practice for the practising veterinarian.

Many animals that are supplied to the MSU are lame animals. Moreover, the overall culling of animals is often based on lameness, given that there is a high percentage of clinical (= visible) lameness and a very high percentage of sub-clinical (= not immediately visible) lameness within dairy farming as a whole. It is expected that there will be more animals with (potentially serious) lameness that will be culled through the MSU. This translates into a lower animal welfare risk if the MSU is available, given that these animals no longer need to be transported and do not run the risk of possible deterioration during transport.

There are expected to be **equal risks** to animal welfare between the scenarios with regard to the withholding of care. Withholding of care may occur in all manner of situations and there is insufficient evidence (data, literature) that shows that this would be exacerbated through the use of an MSU.

Table 10.1. Identification of differences in practices between the scenario using the MSU and the scenario without the MSU, where the latter scenario can be divided into emergency slaughter, euthanasia, and the high-risk group for routine transport and slaughterhouse.

Stage (Phase A-F)	With MSU	Without MSU		
	MSU	**Emergency slaughter**	**Euthanasia**	**Routine transport and slaughterhouse 'high-risk group'**
(A, B, and D) Extended stay at farm, including left behind alive	Possible	< 3 days; possible	Possible	Possible
(C) Loading – walking to lorry / MSU	routine, unless animal is recumbent	N/A	N/A	routine
(E) Live transport	N/A (unless following rejection)	N/A	N/A	routine
(F) Unloading lorry - walking slaughterhouse	N/A	N/A	N/A	routine
(C and F) AM inspection	routine, by supervising veterinarian, incl. temperature	by practising veterinarian	N/A	routine by NVWA
(C and F) Stunning and killing	standard, by MSU employee	standard, by practising veterinarian	standard, by practising veterinarian (or farmer)	standard, by slaughterhouse employee
(C and F) Bleeding	standard, by MSU employee	standard, by practising veterinarian	N/A	standard, by slaughterhouse employee
(F) Time alive at slaughterhouse	N/A	N/A	N/A	routine

Table 10.2. Identification of the expected differences in terms of risks between the scenario using the MSU compared to standard practice, with the latter being sub-divided into emergency slaughter, euthanasia and the high-risk group for routine transport and slaughter, and shown by welfare impact or hazard.

Hazards or welfare impact	**MSU risks compared to other routes**	**Risks compared to MSU**		
	MSU	**Emergency slaughter**	**Euthanasia**	**Routine transport and slaughterhouse 'high-risk group'**
(A and B) Withholding necessary care prior to animal registration	equal	equal	equal	equal
(C and F) Rejection at AM inspection	higher	lower	N/A	lower
(D) Withholding of necessary care following rejection	equal	equal	N/A	equal
(C) Loading – walking to lorry	equal to lower	N/A	N/A	equal to higher
(E) Transport	lower	N/A	N/A	higher
(A to F) Stress prior to slaughter process	lower	N/A	N/A	higher
(A and D) Killing by unqualified person	smaller to equal	higher	higher (particularly if carried out by farmer)	equal
(C and F) Inadequate stunning	higher	lower	N/A	lower
(C and F) Insufficient(ly) (rapid) bleeding	higher	equal	N/A	lower

5.2. Phase A: on the farm, before registration

When a bovine animal is suffering from a condition, the farmer can normally decide either to do nothing, to provide (further) treatment for the animal, to have it euthanised by a practising veterinarian or to register the animal for transport or emergency slaughter. Cattle could also be killed by persons other than the veterinarian, such as by the farmer or by a slaughterhouse employee attending on site, outside the context of emergency slaughter or the MSU (personal communication combi teams, January 7, 2020), however there is no hard data in this regard. Finally, the farmer may request that the owner of the MSU dispatch the MSU. If the MSU is already present for an animal, the farmer may also choose to register another animal on site. **Until the decision has been taken to**

engage the MSU, there is no difference in the type of hazards and animal welfare risks between whether or not the MSU is used.

Given that registration of an animal for the MSU takes place with the owner of the slaughterhouse, it cannot be verified whether and how often that owner has put in place a waiting list for animals to be supplied for AM inspection.

The hazards in this initial phase (A) – prior to anything taking place – are in principle the same in both the scenario with or without the MSU. The hazards include all risk factors that may lead to the relevant condition. Occasionally these hazards are clear (indicated at registration, or listed on one of the forms completed by the farmer or supervising veterinarian), however, equally often they are not. Neither is the reason for animals being culled always known. **As such, potential hazards present may similarly have not been identified. For the NVWA, this uncertainty means that there is no systematic and comprehensive picture of what really happens at livestock farms during this phase. This uncertainty applies to both scenarios.**

Hazards that have been distilled from the reports of the Inspection directorate include 'having to walk while lame', 'difficult calving' and 'dead calf', 'letting animals live', 'old cows', 'drenched with moisture - sick cow' (please see Annex 7 'Animal welfare: Hazards and effects on animal welfare'). The other information regarding the animal relate primarily to welfare effects, in which the underlying hazards can occasionally be traced back the literature and occasionally cannot. Milk fever, for example, is caused by a calcium deficiency in the blood. However, why an animal should have an acute back injury, for example, is guesswork if this has not been specified by the farmer or becomes clear from the circumstances in which the animal was.

It is clear that all – with the exception of one – of the well-known welfare effects identified in the MSU for phase A can be traced back to the 'Good health' Welfare Quality principle. **Moreover, if the MSU were not available, these welfare effects would still exist. As such, they are not MSU dependent.** The criteria of 'absence of injuries' (such as claw disorders as a result of non-infectious diseases) and 'absence of disease' (such as milk fever due to a calcium deficiency or protracted milk fever due to a negative energy equilibrium) are key in this regard. On one occasion, in relation to an animal registered for the MSU, the criterion of 'absence of pain due to management interventions' (aspiration pneumonia caused by drenching the cow) was listed, however in fact the cow was already sick and therefore falls under the previous criterion on disease.
Yet another occasion – in relation to the MSU – cited a skinny cow, which could be caused by the animal having been unable to absorb the correct nutrition, thus falling under the 'Good nutrition' Welfare Quality principle. It should be noted in this instance that there is an interplay between 'Good nutrition' and 'Good health'; weight loss can also arise as a result of an underlying disease and an underlying disease such as (lingering) milk fever can be caused by a feeding policy that does not match this specific (high-production) cow. **There is a wide range of underlying hazards, however in this context the health of the cow, which leads to the culling of the animal, is the principal element.**

The data analysis (please see Chapter 4 'Data analysis') shows that that majority, some 65-80%, of the animals supplied to the MSU are lame. Overall, in terms of the entire dairy farming sector, between 15-25% (Amory et al., 2006; Boer et al., 2013; Visser et al., 2015; Cook et al., 2016) of dairy cows will be clinically lame (up to 80% if taking into account sub-clinical cases (in (Bruijnis, 2012)) and 15% is culled for that reason (please see paragraph 4.2. Replacement of dairy cattle)). **The MSU therefore mainly culls animals suffering from lameness,**

however is not itself the cause of that lameness. In terms of origin or cause, there will be no difference between the scenarios with or without the MSU. Please see paragraph '5.2.2. Additional information of welfare impact due to lameness' and Annex 8 for more information on lameness and claw diseases.

5.2.1. Welfare impact

Welfare effects observed on the farm in animals registered for the MSU vary from lameness to downers with underlying physical injuries or diseases (please also see paragraph 4.2.3.). Annex 7 'Animal welfare: Hazards and effects on animal welfare' provides an estimate of the severity, the duration and the impact of the welfare effects where possible. The welfare effects were documented during the pilot with the MSU in operation. The impact (severity x duration) estimates are derived from reports that were previously drafted by the WUR in the context of the red meat and dairy supply chains and, as such, have not been specifically established for the MSU (Visser et al., 2014a; Visser et al., 2014b; Visser et al., 2015).

The severity of the welfare effects in phase A varies from moderate to very severe (score of 3-5 on a scale of 1-5) and is mostly severe to very severe. The duration varies from short to long (score of 1-3 on a scale of 1-3) and is mostly medium to long. The impact varies between 4-7 on a scale of 7, with the score of 4 only occurring once, the rest being higher. These scores imply that the welfare impact on the cattle is usually significant. Most animals that were supplied to the MSU were lame, which also yields a significant welfare impact score (score of 5-6 out of 7). The severity, duration and welfare impact for a number of welfare effects, such as abomasal bleeding and fever, have not been determined by experts.

At this stage, using the data currently available, no quantitative difference between the presence or absence of the MSU could be identified in relation to welfare impact. The welfare effects essentially are the same whether or not an MSU is available (please also see paragraph 4.2. 'Replacement of dairy cattle'). One conceivable complication is that animals might remain in this 'pre-registration' situation for too long, resulting in the impact on individual animals increasing, if it has not already peaked; as the duration increases (i.e. the animal suffering longer), so too may the severity if it is not already very severe (e.g. the animal may become sicker or even more lame). As such, this is a case of unnecessarily prolonged suffering (please see Annex 7 'Animal welfare: Hazards and effects on animal welfare') ; this is expressed by the animal, for example, in the form of heavy breathing, panting, sweating or shivering.

With the MSU, the animal must be granted access to slaughter, taking into account any waiting periods for veterinary medicinal products and the animal must in any case not have a fever at the time of the forthcoming AM inspection at the housing unit. All animals will be subject to temperature checks to rule out fever. If the animal is suitable for the MSU (thus pilot), it is in principle unfit for transport or for emergency slaughter (3-day emergency slaughter deadline has expired). If the animal is similarly unfit for the MSU, then euthanasia and disposal to Rendac is the only immediate option. An indirect solution is to delay registration with the MSU until the animal – whether or not following treatment – has recovered sufficiently (no longer has a fever) or to cease treatment and allow the waiting period of the veterinary medicine to expire in order to have the animal killed at the MSU. The indirect pathway chosen will in any case extend the animal's suffering if no/insufficient pain relief is provided, where it will depend on the condition and chosen treatment whether (sufficient) recovery can reasonably be expected.

If the MSU is not available for that same animal, then similarly here it will be the case that the animal is not fit for emergency slaughter or transport, with the only direct route being euthanasia. Euthanasia may be delayed until the practising veterinarian attends the farm for another purpose, in order to reduce veterinarian costs. This may cause the animal to suffer for longer (Hindle et al., 2010). Attempts can still be made at this stage to ensure the animal still qualifies for emergency slaughter or to allow it to recover sufficiently – whether or not through treatment – in order to get it fit for transport and slaughter. The indirect pathway will in any case extend the animal's suffering if no/insufficient pain relief is provided, where it will depend on the condition and chosen treatment whether (sufficient) recovery can reasonably be expected.
In both scenarios – with and without the MSU – it may be the case that the situation preceding registration for intervention (MSU, euthanasia, emergency slaughter, transport to slaughter) may take too long, resulting in a possible increase in the welfare impact.

In terms of allowing an animal suffering from a condition to live, a number of aspects may play a key role, such as:

- The farmer will weigh up whether or not a dairy cow is still able to recover and will be able to produce milk again or whether there are financial gains to be made by having it slaughtered. The animal may not receive the treatment required for the condition on the basis of economic reasons (RDA, 2007).
- Due to the waiting periods of veterinary medicinal products prior to slaughter, the animal will not receive the treatment required for the condition (Enforcement/Inspection records).
- In order to limit deregistration on I&R due to 'death'[15], farmers will want the animal to be slaughtered for consumption, meaning that they will wait until the animal is once again fit for MSU/emergency slaughter/transport to conventional slaughter. The animal is then deregistered on I&R due to slaughter to the name of the slaughterhouse (Slachthuis Dokkum website; https://www.mobielslachthuis.nl/).

The underlying reasons for allowing the animal to live longer than is desirable for the animal apply to all animals suffering from a condition, even if the MSU cannot be used.

5.2.2. Additional information on the effects of lameness on welfare

Because the majority of the animals that were culled through the MSU were lame, this section will provide more background information on the effects of lameness on the welfare of cows.
Lameness and claw disororders cause both physical and mental impairment of the animal's well-being. Lameness is painful and causes an animal to walk less, exhibit abnormal recumbent behaviour and causes changes to its feeding behaviour/patterns.
Thereafter, the physical condition of animals may deteriorate, leading to less production and reduced fertility. Normal dairy cattle behaviour, such as walking, standing, behaviour when in heat, lying down and getting up is affected by lameness (Cook & Nordlund, 2009; EFSA AHAW Panel, 2009; Whay & Shearer, 2017; Gezondheidsdienst voor Dieren, 2019b). In addition, lame animals are more susceptible to secondary diseases, such as mastitis and metabolic diseases, such as ketosis. In addition, damaged hocks are more common in lame animals due to protracted recumbent behaviour. Severe hock damage can conversely also cause lameness (Kester et al., 2014).

[15] Recent quality assurance systems aimed at achieving sustainability in the dairy sector aim to achieve a maximum mortality rate of 2% per year.

Claw lesions are painful and are the principal reason underlying adapted movement when suffering from claw disorders (EFSA AHAW Panel, 2009; Whay & Shearer, 2017). Although the injury may be small, a larger area may be painful due to inflammation (Whay & Shearer, 2017). Cows suffering from chronic claw disorders may develop hyperalgesia, with these animals developing a higher sensitivity to pain. Hyperalgesia exacerbates the suffering of animals and that of chronically lame animals in particular. The recovery time from lame to fit and free of pain is often long (Whay & Shearer, 2017).

The suffering associated with severe lameness is itself severe. Weight loss and loss of strength can quickly lead to exhaustion and weakness, resulting in the animals no longer being able to walk. Severe lameness can be caused by injuries, but is more often related to sole ulcers, whiteline disease or interdigital inflammation, where the infection has penetrated further into the deeper layers of the claw and foot. The animal's suffering will be aggravated by failure to identify the condition in time or due to inadequate treatment. In severe cases, euthanasia is often the best option (Whay & Shearer, 2017). Severely lame animals that do not fully recover, for example, due to chronic complications, will be in pain for a longer period of time until they are slaughtered or killed (EFSA AHAW Panel, 2009).

Animals may only be transported to the slaughterhouse if they are fit for transport in accordance with the requirements set out in the Animal Transport Regulation (Regulation (EC) 1/2005)[16]. Animals which are culled due to lameness are unfit for transport if they cannot move without pain, cannot support themselves on four legs, cannot walk or lie down unaided (Eurogroup for Animals et al., 2012; Consortium of the Animal Transport Guides Project, 2017). Please also see section 3.3.3. Additional information on fitness for transport of dairy cattle culled to slaughterhouse.

5.3. Phase B: After MSU registration, euthanasia, emergency slaughter or transport

This phase deals with the period following registration for the MSU or, as more common in regular practice, for euthanasia, emergency slaughter or transport. If possible, the animal will be moved to a separate holding pen/sick bay. In relation to the MSU, having the animal removed from the main herd is a key requirement (please see Slachthuis Dokkum website and pers. comm. on MSU visit). It is unclear whether this is a strict requirement in routine practice, however, it is expected that it should not apply to euthanasia and emergency slaughter, but may be applied if possible.

The hazards that (continue to) play a key role during this phase are: allowing effects on the welfare of animals to persist (unnecessary prolonged suffering), whether or not with treatment, but equally allowing animals with a condition (i.e. lameness) (see previous information on lameness) to move, removal of the animal from familiar members of its kind (social stress) aimed at relocating the animal to a temporary holding pen/sick bay and any negative interactions with people associated with those actions (fear of humans).
These are the Welfare Quality principles 'Good health' and 'Normal behaviour' (please see the Table Hazards: an overview).
Types of hazards that may occur at this stage will most likely be the same for both scenarios (with/without MSU). For the NVWA, this uncertainty means that there is no systematic and comprehensive picture of what really happens at livestock farms during this phase.

[16]Council Regulation (EC) No 1/2005 of 22 December 2004 on the protection of animals during transport and related operations and amending Directives 64/432/EEC and 93/119/EC and Regulation (EC) No 1255/97, OJ L 3, 5.1.2005, p. 1–44

Please note that the animal may be rejected for a variety of reasons (please also see section for phase D) from being registered for the MSU, for example, due to the cow's health status (fit for transport or too sick for slaughter, i.e. MSU), use of veterinary medicinal products (waiting period) or an overly full MSU schedule. The recommendation of the owner of the slaughterhouse (provided by phone) may be to have the animal euthanised by the practising veterinarian (pers. comm. visit to MSU), however what happens exactly is unknown. The farmer may wait, the animal may receive further treatment or it may be placed on routine transport to the slaughterhouse, to an assembly centre or to another farm. **The number of animals that are actually rejected by the owner of the MSU upon registration is not known**.

In the scenario without the MSU, an animal registered for emergency slaughter may also be rejected (denied access to slaughter, GTS) by the practising veterinarian. It is expected that the animal will then usually be euthanised, however it may also be the case that an animal is left behind alive. A transporter can also reject an animal if it should appear that the animal is unfit for transport. If an animal is already present at an assembly centre, then the supervising veterinarian (TDA) may similarly decide that the animal is unfit for transport during the housing or loading inspection (please see phase C). The animal will then usually be left behind alive, after which it is euthanised, killed through emergency slaughter or is supplied for transport to slaughter on another occasion thereafter. **Rejection upon registration may occur in all scenarios, both with or without presence of the MSU.**

5.3.1. Welfare impact

The welfare effects in play during this phase may be distilled from the records of the Inspection directorate or from the literature. The welfare effects present during phase A in fact continue to exist, however specifically in phase B the key effects are: unnecessary prolonged suffering, forcing a lame animal to walk, social stress and fear of humans. The severity of these specific consequences on welfare are estimated to range from moderate to very severe (score of 3-5 out of 5). The duration of the effects on welfare is currently estimated to be short to long (score of 1-3 out of 3), however have not been forecast in relation to this specific phase. It is therefore vital to emphasise that the **duration of the effects on welfare during this phase depend on the schedule and response times of the MSU, the practising veterinarian (euthanasia or emergency slaughter) or transporter.**
The welfare impact has been estimated between moderate to very high (score of 3-7 out of 7).
There is expected to be no difference between the various scenarios in terms of welfare impact.

Relocating and handling dairy cattle on the farm can lead to aversive behavioural responses in cattle (e.g. (Abramowicz et al., 2013)). Particularly if human actions relate to other purposes than milking, such as claw treatments, and in new/unfamiliar situations; therefore including when animals are normally very calm (in (Lindahl et al., 2016)). Milking is a well-known occurrence for cows and is generally linked to being given concentrate and udder relief, resulting in the animal having a less aversive response.

Aversive (anxiety) types of behaviour range from stopping, backing away, turning around, and running away to headbutting in the direction of the human and kicking with the hind legs (dairy cattle: (Lindahl et al., 2016); bison: (McCorkell et al., 2013); the behavioural response is stronger in bison than in dairy cattle, given that they are less used to being handled by humans).

Behavioural responses inter alia depend on how the farmer interacts with the animals and animals' previous experiences with humans; whether objects are used (e.g. a prod), whether they are pulled using a rope halter, and whether the handlers hit or prod the animals, etc. (in (Lindahl et al., 2016)). Other physical and physiological effects on the animal include: bruising and a significantly elevated heart rate resulting in the animal experiencing stress and making impairment of its well-being likely (McCorkell et al., 2013; Grandin, 2015; Lindahl et al., 2016).
No difference is expected between the various scenarios in terms of the behavioural responses and their effects when animals are moved to a holding pen/infirmary.

5.4. Phase C: MSU, emergency slaughter, euthanasia or loading transport
This phase deals with the period between the arrival of the MSU operator, emergency slaughterer or transporter and the moment that party departs.
In broad strokes, the procedure is as follows: the animal will, if possible, already be in a separate holding pen/unit/sick bay with or without some of its peers, after which the animal:

- is subjected to the AM inspection (AM inspection takes place on an individual basis for both MSU and emergency slaughter) and is killed (emergency slaughter, animals denied access to slaughter or MSU animals that can no longer walk), or
- is led to the MSU following the AM inspection and is individually loaded into the vehicle, stunned and killed,
- or the animal is led to the transport trailer and loaded onto the vehicle without an AM inspection. If the animal is to remain in the Netherlands, the driver of the live cattle transport may determine that an animal is unfit for transport. If the animal is to be exported outside the Netherlands, the animal must undergo a housing or loading inspection (certification for transport abroad): this inspection is carried out by an NVWA supervising veterinarian and is less comprehensive than the AM inspection (inspection is carried out group by group and not all animals undergo temperature checks) and mostly takes place at an assembly centre (NVWA Instructions regarding export certification of live cattle from the Netherlands). If an animal has been transported to an assembly centre, it will be reloaded there.

Under Regulation 1099/2009[17], animals must always be stunned before they are killed – the exception being ritual slaughter at a slaughterhouse. The stunning of adult cattle for slaughter in the Netherlands virtually always is carried out using a penetrating captive bolt stunner (captive bolt pistol) (pers. comm. Inspection, January 8, 2020), with a bolt from the bolt pistol physically entering the head of the animal. If performed correctly, this is followed by severe and irreversible brain injury (concussion), rendering the animal unconscious and unable to regain consciousness (Oliveira et al., 2018), but not dying immediately. As such, it is referred to as a 'simple stunning' method, which means that is must be followed by a killing method.

In the Netherlands, the subsequent method of killing for adult cattle intended for slaughter is almost always bleeding, whereby the carotid arteries are severed. If the animals have been denied access to slaughter, the pithing (/spinalisation/laceration) is applied following the use of the captive bolt pistol instead of bleeding. Pithing destroys the brain in such a way that the animal dies quickly. The practising veterinarian (company veterinarian) may also kill animals using the captive bolt pistol and pithing, however may equally do so through use of a lethal injection.

[17]Regulation (EC) No 1099/2009 of the European Parliament and of the Council of 24 September 2009 on the protection of animals at the time of killing (text relevant to EEA). Document 32009R1099.

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Hazards that play a key role at this stage, phase C, include the suitability of the surface to walk on, the negligent loading of animals, (due care (EFSA AHAW Panel, 2004)), animals being forced to walk when lame, removal of the animal from familiar members of their species, the use of a cattle prod, the fixation of animals, negative interactions with humans (whether or not in the past), inadequate stunning (animals still conscious), delayed or overly slow bleeding allowing the animal to regain consciousness (please see Annex 7 'Animal welfare: Hazards and effects on animal welfare'). This relates to the criteria of ease of movement, injuries, pain due to management interventions, social behaviour and the human-animal relationship which all relate to the Welfare Quality principles of 'Good housing', 'Good health' and 'Appropriate behaviour' (please see Annex 7 'Animal welfare: Hazards and effects on animal welfare').

The way in which the animals are treated at this stage depends on several parties: the farmer and, depending on the scenario, the MSU employee, the supervising veterinarian (MSU or transport in the case of export abroad), the practising veterinarian (euthanasia or emergency slaughter) and the transporter.

Differences between the possibility of the application of the MSU lie in the following areas:

- Often only individual or several animals are culled from a farm (Dixhoorn et al., 2010); it is expected that cases of emergency slaughter will more often relate to individual animals, as acute events (accidents) are involved. If the animal is transported to the assembly centre or slaughterhouse, then the animals are usually placed in the trailer in a larger group.
- Extensive on-site AM inspections (only one or several animals need to be inspected, always including temperature checks) by a supervising veterinarian are only conducted when the MSU is used. In relation to emergency slaughter, the less extensive AM inspection conducted by a practising veterinarian is used (please see NVWA document on Explanatory notes on emergency slaughter). In the case of domestic transport, only the driver – in addition to the owner/farmer – of the live cattle transport is able to determine whether the animal is fit for transport; AM inspection (less comprehensive) by a supervising veterinarian only takes place at the slaughterhouse in such cases. In the case of exports, an inspection in the housing unit or at the loading flap is conducted by a supervising veterinarian, which determines whether the animals are fit for transport. These inspections usually only take place at the assembly centre after transport has taken place. **As such, rejection at the AM inspection is most likely in the case of the use of the MSU.** Roughly 9% of the MSU animals supplied were denied access to slaughter at the AM inspection (please see MSU data analysis). No data is available regarding how often a veterinarian will deem an animal unfit during the AM inspection for emergency slaughter. In the case of routine slaughter, the percentage of animals that is denied access to slaughter is approx. 1%.
- Whether the animal is required to walk to the desired site (site of farm, MSU or transport trailer); emergency slaughter always takes place in the housing unit – this is not required for the MSU (but is an option).
- NB Bleeding in the housing unit in cases of emergency slaughter is not expected to preferred by the farmer, due to the amount of blood at the farm and the associated hygiene and animal health risks, meaning that the MSU would be preferable to the farmer over emergency slaughter!
- At the MSU, the slaughterhouse employee would fire whilst positioned next to the animal, with his/her arm moving over a partition, with limited space to carry out the actions. At the same time, the head of the cow must be held in place by the rope halter – this requires a high degree of professional skill. It

must be done correctly if it is to result in truly irreversible stunning. The design of the MSU therefore may play a key role in the effectiveness of the stunning. At the same time, MSU employees are highly skilled and are conducting routine work – practising veterinarians will often lack experience of routine practice and it is estimated that they will only handle the penetrating captive bolt gun on one up to several occasions per month (pers. comm.), resulting in a higher likelihood of inaccurate stunning in cases of emergency slaughter compared the conventional slaughterhouse (NVWA document Emergency slaughter on the farm).

- It is expected that a mobile slaughterhouse will gave less available capacity compared to a conventional slaughterhouse and as such will be more sensitive to technical faults or replacement of staff (Eriksen et al., 2013).
- In the MSU, the bleeding process may display the hallmarks of throat cutting form ear to ear (‘open head’ slaughter). The way in which the animal lies in the MSU can make cutting difficult.
- At the MSU and in the case of emergency slaughter, the animal is bled in a recumbent position, whereas at the slaughterhouse the animal is shackled during bleeding. In recumbent bleeding, it may be the case that the animal adopts a position that partially occludes the carotid artery or leads to the artery silting up, resulting in slow bleeding. In such cases, succession of death may take up to 10 minutes (Terlouw et al., 2016).
- In the MSU, an additional check is carried out by the supervising veterinarian to verify that the animal is unconscious following stunning and cutting. After the last animal has been processed on site, the MSU employee cleans the equipment and boots, closes the flap, cleans the exterior of the vehicle and departs. While driving, checks to verify whether the bleeding process is proceeding well can no longer be carried out. The MSU and emergency slaughter differ from routine slaughter at the slaughterhouse in this regard, where animals immediately enter the remainder of the slaughtering process, where the process of dying takes less than 10 minutes.
- Farmers may choose to have an animal that is unfit for transport or unsuitable for emergency slaughter killed in another way than through the practising veterinarian, due to the associated costs ((Hindle et al., 2010)+ consultation directorates Inspection and Enforcement). The MSU would provide a solution for this group of animals.

NB: According to the estimates of the combined teams of the Inspection and Enforcement directorates (joint inspection carried out in December 2019), a number of the animals supplied (e.g. due to trauma from calving) were fit for slaughter, however the emergency slaughter period of three days had expired. The reasons for exceeding the emergency slaughter period are unknown.

5.4.1. Welfare impact

Effects on welfare that occur range from discomfort when walking (as a result of a suboptimal surface) to fear and pain as a result of regaining consciousness due to inadequate stunning and bleeding. The severity of the effects of welfare at this stage range from limited to very severe (score of 2-5 out of 5). The duration of these effects is short to very long (score of 1-3 out of 3). The duration and welfare impact is not known for all of the effects on welfare. The variation of the welfare impact is based on the literature across the entire scoring scale (score 1-7), where discomfort when walking across a coarse/uneven floor has no or hardly any impact (score of 1) whereas fear and pain due to inadequate stunning, with the animals subsequently being conscious when cutting, having an enormous welfare impact (score of 7). As such, the welfare effects in relation to stunning and killing have the highest welfare impact (score 5-7 out of 7).

However, it is precisely when loading an animal into the MSU that is it unclear whether or not this is desirable: from an animal welfare perspective, on the one hand – lameness also scores high on welfare impact (score of 5-6 out of 7) – and from the perspective of a uniform approach to routine transport and slaughter (fitness for transport) (Annex 6) on the other. A score for lameness may help make the decision for an animal to be stunned (and killed) earlier (for example, in the housing unit, in front of the flap or in the transport trailer) (please also see Annex 8 Lameness and claw conditions). EFSA states that there are animal-based indicators for lameness in dairy cattle for use on the farm and that these may also be of use during AM inspections at the slaughterhouse, provided that they are adapted to the conditions there (EFSA BIOHAZ Panel, 2013). In December 2019, during the MSU pilot, the combined NVWA teams of the Enforcement and Inspection directorates made use of a scoring system proposed by BuRO (please see section '5.2.2. Additional information on 'lameness' and section '4.6.2. Results of joint inspections'). That experience demonstrated that scoring of lameness using the system was carried out in a relatively uniform manner, but that the interpretations and any subsequent actions were not uniform/clear (Annex 4). This touches on the broader debate regarding when an animal is fit for transport and when it is not. **There is therefore a grey area both for the MSU and for routine transport to slaughter regarding how to deal with lame animals and the choice of whether or not to load them by having them walk on their own steam.**

A Swedish study conducted among cattle slaughtered in a mobile slaughterhouse (Hultgren et al., 2017) found that driving the cattle from the site of the AM inspection to the stunning site up to the time of stunning can be (additionally) stressful depending on how the animals are driven. They indicate that a short handling time and few negative human-animal interactions can be beneficial to the welfare of the cattle. Negative human-animal interactions can also extend the time it takes the animal to makes its way to the mobile slaughterhouse. In the Swedish study, the time it took for the animal to arrive at the stunning area in the mobile slaughterhouse was 3 minutes (between 0:05-18:41 minutes) on average.

The stunning itself also has an impact on the stress response of animals and also affects the quality of the meat (in (Eriksen et al., 2013)), where animal parameters indicate that a mobile slaughterhouse is perceived as less stressful than a conventional slaughterhouse up to the moment of stunning/killing (for more details, please see Phase F at the slaughterhouse).

Stunning, bleeding and the development of the right equipment can however be more problematic in mobile slaughterhouses than at a conventional slaughterhouse (Eriksen et al., 2013). In a study conducted in sheep-lambs there was a significant lengthening of the time from stunning (mobile slaughterhouse: captive bolt pistol; conventional slaughterhouse: electric) to sticking/bleeding (stun-stick interval) in a mobile slaughterhouse compared to a conventional slaughterhouse (difference of ± 5.8-15.4 secs more; with a maximum average time of 24.3±0.5 secs). In the sheep study, this still falls within the 30-second range, which, according to Grandin et al. is required to prevent an animal from regaining consciousness during the bleeding (in (Verhoeven, 2016)). The quality of the stunning was good for most sheep at both the mobile and the conventional slaughterhouse, although there were a number of incidents at the conventional slaughterhouse where animals showed signs of consciousness (rhythmic breathing and eye reflexes) (Eriksen et al., 2013).

In the study by (Hultgren et al., 2017), the time in the stunning area in the mobile slaughterhouse was on average approximately half a minute (0:08-2:08 mins). The time from stunning to sticking was on average over 1.5 mins (0:24-

3.22 mins), with the cows primarily having a longer stun-stick interval (compared to the bulls). In another study by Hultgren et al., it was found that the interval between stunning and sticking for bleeding was significantly longer (difference of nearly a minute; 104s in MS and 44 in conventional slaughterhouse) in the mobile slaughterhouse than in the regular small-scale slaughterhouse (Hultgren et al., 2018).

Studies that looked at the effectiveness of stunning methods in cattle showed that 2-12% of cattle stunned with the penetrating captive bolt gun had to be shot several times (compared to 29-46% for non-penetrating captive bolt pistols without a rod) (Neves et al., 2016; Oliveira et al., 2018). Most cattle (99%) in the group of animals stunned with the penetrating captive bolt pistol collapse immediately after being shot. Eye movements and behaviour was observed in 1% of the animals, with the animals attempting to stand up (Oliveira et al., 2018). In the study of (Neves et al., 2016), no signs of consciousness (tongue pinching, blinking, rhythmic breathing) were present in the stunned animals both at 20 secs and 60 secs after stunning. In another study, all the animals had been instantly stunned effectively with a penetrating captive bolt pistol, with none of the animals (bulls) having a brain EEG (electroencephalography) pattern that would be equal to consciousness (Gibson et al., 2019).

At the Swedish mobile slaughterhouse, 10% had to be shot again (Hultgren et al., 2017). Compared to a regular small-scale slaughterhouse, animals had to be shot and stunned again more often at the mobile slaughterhouse (Hultgren et al., 2018).

It is not uncommon for blood to enter the respiratory tract during the bleeding of animals that have been ritually slaughtered, however, this has also been observed in animals that are first stunned with a captive bolt pistol and are cut standing up (fixated). This can cause (additional) suffering in the event of a lack of stunning (Gregory et al., 2009).

5.5. Phase D: Animal left behind alive on the farm

Animals that are not given access to slaughter and therefore are not given access to the MSU may be left behind alive on the livestock farm, whether or not alongside the recommendation for the animal to be euthanised by the practising veterinarian. This occurred during the pilot with the MSU, in relation to which it should be emphasised that in the final weeks of 2020, in principle, no animals were left behind alive, having been stunned and killed by the MSU employee (phase C) (previously carried out, but not always). During all other weeks of the pilot, a number of animals (n=32) were rejected at the AM inspection of the MSU and these animals were later supplied to the MSU again or occasionally placed on either domestic transport or transport abroad (please see Chapter 4 Pilot data analysis). If in doubt, the supervising veterinarian can choose to log a report in the MOS system of the NVWA, so this farm can be reviewed more closely. In fact, supervising veterinarians may also opt to do so during an inspection at the housing unit or loading flap for routine transport for export abroad.

As outlined in phase B, a living animal may also be left behind if such animals have been supplied for emergency slaughter or routine transport. The likelihood of this happening for animals supplied for emergency slaughter is not considered very high, given that the practising veterinarian is also able to perform euthanasia. This is expected to be more common in relation to routine transport. The true extent of animals being left behind, however, for the scenario without the MSU is unknown based on current data (not linked to I&R, given that animals have not been moved).

Precisely what happens to the animals left alive, similar to phase B, is unknown in this instance. The farmer may wait, the animal may receive treatment or may ultimately be placed on routine transport to the slaughterhouse, to an assembly centre or possibly to another farm.
As such, animals may be left behind both in the scenario with and without the MSU – with the exception of euthanasia. The probability of an animal being rejected at the AM inspection is greater in relation to the MSU, however, at the same time, the likelihood of animal being killed/euthanised on site is higher in relation to the MSU than in relation to rejection for transport to slaughter. This is because the MSU employee is permitted to kill the animal, whereas in the event of refusal for routine transport the farmer must have a practising veterinarian attend.

The hazards that play a key role at this stage are chiefly the persistence of the hazards of phase A and B, with unnecessarily prolonged suffering due to the withholding of care being a principal hazard. In addition, the likelihood of a bovine animal being killed by a non-skilled person other than a practising veterinarian may increase in this scenario, however, there is no data in this regard. The probability is estimated to be very low. These hazards fall under the Welfare Quality principle of 'Good health'.

<u>5.5.1. Welfare impact</u>

The welfare impact is comparable to that outlined under phase A and B, where the unnecessarily prolonged suffering is crucial in particular and which varies in terms of its welfare impact, but is nevertheless estimated to be high to very high (severity score of 5, duration score of 1-3, impact score of 5-7) (depending on the type of condition and whether or not treatment is provided).

The welfare impact of incorrect stunning and killing by an unqualified person is in principle the same as in phase C when stunning is conducted ineffectively and is high to very high (severity score of 5, duration score of 2-3, score 5-7 out of 7) (please see Annex 7 'Animal welfare: Hazards and effects on animal welfare'). The animal will experience fear and pain and possibly suffocation and the regaining of consciousness.

5.6. Phase E: Routine transport 'high-risk group'

Animals normally suitable for the MSU would de facto be unfit for transport. This is in fact an unauthorised type of routing, in relation to which it should be noted that the characterisation of whether an animal is fit for transport is a grey area. It may therefore be that for certain animals the case of whether transport is permitted or not is in doubt from a legal point of view. Outside of the Netherlands/the EU, fitness for transport is similarly a key aspect of animal welfare, given that there may, for example, be other interpretations of open-ended standards or there may be guidelines in place but no enforced rules and it may be more economically profitable for these animals to be transported regardless (USA: (Edwards-Callaway et al., 2019)).

Once on the transport vehicle, the animal is transported to an assembly centre or slaughterhouse alive, occasionally with stopovers to pick up more animals (please see Annex 7, Welfare Quality principle 'Appropriate behaviour'). It may also be that animals are transported to another farm for meat production, for them to continue on to the slaughterhouse at a later date (Dixhoorn et al., 2010).

In 2008 and 2014, extensive hazard identifications were carried out by Wageningen Livestock Research (WUR)(Reenen et al., 2008; Visser et al., 2014b)

for the transport phase and the EFSA-AHAW panel similarly drafted opinions on the matter(EFSA AHAW Panel, 2004;2011)
The hazards and the resulting risks set out in the literature have not been exhaustively included in this comparison between the hazards/risks associated with the MSU and non-MSU scenarios, because transport as a whole is absent from the MSU scenario (Annex 7). In this case, transport is included within the Welfare Quality principle of 'Good housing'.

Key aspects during the transport of animals are fitness for transport, the handling of animals, animals' unfamiliarity with transport, diligent inspections (conducted by the driver) before and during transport, social (group) stability (mixing of unfamiliar animals), feed and water intervals, degree of occupancy and roof height that allow normal movement and resting, climate, travel times and resting periods, 'careful' driving so as to allow animals to maintain their balance, introduction of pathogens, in addition to administrative aspects such as contact in case of emergency and training of the carer/driver (EFSA AHAW Panel, 2004; Reenen et al., 2008; Dixhoorn et al., 2010; EFSA AHAW Panel, 2011).

Slaughter at the farm ensures that animals need not be transported, that animals are not exposed to an unfamiliar environment and potential withholding of feed and water (McCorkell et al., 2013). If an MSU is unavailable, animals will only be able to be euthanised (no economic gain) or killed through emergency slaughter, however, in such cases the animal must have had an accident. **It is therefore expected that the likelihood of attempts to get animals transported is greater if an MSU has not been made available compared to the scenario with the MSU.**

5.6.1. Welfare impact

The extent of the disadvantages during the process up to slaughter is related to the type, the duration and the intensity of the individual pre-slaughter challenges and the vulnerability of the animals. Transport is one of those challenges and is characterised as a considerable stressor (in (Eriksen et al., 2013);(EFSA AHAW Panel, 2004)).

The hazards of transporting healthy animals, free of any conditions are associated with elevated physiological stress measured in behaviour, heart rate, respiration, rectal temperature and cortisol and adrenaline (McCorkell et al., 2013). Fewer bruises had to be trimmed from the carcasses (trim loss) of bison that were slaughtered using a mobile slaughterhouse and therefore did not require transport. These bruises were caused by the more agitated behaviour of the animals during the pre-slaughter period and may be an indicator of reduced welfare. There was no trim loss for the bison that were slaughtered at the farm. It was, however, noted that any bruises that had occurred when the mobile slaughterhouse was used may also have had less of an effect on the carcass, given that the animals were slaughtered shortly after the contusions occurred. In addition, domesticated cattle are calmer in nature than bison (McCorkell et al., 2013).

The WUR developed an estimate of the welfare impact of the effects on welfare during transport(Visser et al., 2015) specifically in relation to dairy cattle that are placed on transport at the end of their lives. The effects on welfare in this case range from skin lesions/swelling (severity score of 2 out of 5) up to lameness, bone fractures, fatigue and continued suffering (severity score of 5 out of 5 for all). The duration of these welfare effects ranged from short to long (score of 1-3 out of 3). The welfare impact per welfare effect therefore ranges from relatively low to very high (score of 2-7 out of 7). The impact for dairy cattle suffering from a condition, such as lameness, however, is very high (score of 7 out of 7) (Visser et al., 2015).

The group of animals discussed in this report is known to have a condition of which the severity varies. If an animal is already suffering from a condition, this will render transport additionally stressful and the animal's circumstances may deteriorate (Dahl-Pedersen et al., 2018a; Edwards-Callaway et al., 2019). Animals, for example, that have difficulty bearing their own weight on one of their legs should not be transported (EFSA AHAW Panel, 2004). At the same time, it may take longer for the animal to eventually be stunned and killed than when the animal is supplied for the MSU, emergency slaughter or euthanasia. Although the duration of transport need not necessarily impair animal welfare (of animals that are fit for transport)(Hultgren et al., 2018), possibly because the animal is able to rest and recovers from the stress (of the loading, handling, new environment, etc.) during transport.
All in all, the MSU can prevent additional suffering occurring in animals with a condition, because they are not subjected to transport.

5.7. Phase F: Unloading after transport and procedure at the slaughterhouse
This phase in principle only applies to animals within the scenario without the MSU and then only to the group that is placed on routine transport. One exception may be animals that have already been transported, for example, to an assembly centre, and then undergo emergency slaughter there due to an accident – the animal will have been unloaded first. Unloading will initially take place at an assembly centre or at another farm, after which the animal joins the herd and remains there for some time, until it is reloaded – if all goes well – and it resumes its route to the slaughterhouse.

Once at the slaughterhouse, the animal is unloaded, provided there is no clear reason to conclude that an animal is/was unfit for transport. If this is the case, then the animal may or may not be killed immediately depending on the severity of the case (NVWA document Supervision of the welfare of ungulates and farmed game at slaughterhouses).
Hazards surrounding the unloading of animals have been identified in detail by WUR(Visser et al., 2014a) and relate to the layout and the design of the unloading site to the waiting area (too steep, overly high, steps, too narrow), the floor surface (slippery, holes, etc.), barriers/fencing (sharp protrusions, corners, openings), climate (draught, cold, hot, humid), handling of the animals (too much noise with barriers, shouting, hitting, high speed, use of cattle prods, etc.). The unloading process must be carried out with due care and diligence for welfare reasons (EFSA AHAW Panel, 2004).

The layout and the design of the waiting area, the passageways to the site where the animals are stunned and killed are subsequently crucial to welfare (once again, the relevant issues are the hazards such as the floor, fencing, sharp protrusions, etc.) (Visser et al., 2014a).

In relation to stunning and killing (please see section 5.4. phase C), the key hazards are the fixation (including yet again layout and design aspects, floor, handling, position of the animal), the stunning device and method including the handling thereof and a backup plan in the event of a mishap, the interval between stunning and killing, allowing for the animal to regain consciousness, blood in the lungs while the animal is conscious, continuing the slaughter process while the animal is not or insufficiently stunned/not yet dead (Visser et al., 2014a). This final phase is crucial to both scenarios (MSU/non-MSU) and does not differ in terms of the types of hazards present, but may differ in terms of the probability of errors occurring. Specifically with regard to the MSU there may be a slightly elevated risk of inadequate stunning/bleeding compared to regular slaughter, due to the design (lack of space) of the MSU and the significant time pressure (departing with an animal that may not be sufficiently bled) (please see section 5.4. phase C for more detailed information).

5.7.1. Welfare impact

In this final phase at the slaughterhouse, the exposure of an animal to stressors may similarly cause a cascade of responses. It should be noted in this instance that it may be difficult to distinguish between stress responses caused during the transport phase. Either way, stress may activate the sympathoadrenal system or sympathomedullary pathway (SAM pathway) and the hypothalamic–pituitary–adrenal axis (HPA axis), resulting in an increase of catecholamines and glucocorticoids, elevated heart rate, elevated respiration rate, increased body temperature and redistribution of blood more towards the skeletal muscles and brain. In addition, behavioural changes, such as urination and defecation, increased alertness and increased vocalisations, immobilisation or attempts at escape and aggressive behaviour can be expected. The quality of the meat may also be reduced due to stressful experiences in the final phases of the animal's life (in (Eriksen et al., 2013)).

The welfare effects of dairy cattle at the slaughterhouse were assessed by the WUR for their welfare impact (Visser et al., 2015). Many welfare effects are the same as those that may occur in transport and, in addition, the welfare effects surrounding stunning and killing, which have been identified previously in the phase C section are present. The welfare impact ranges from relatively low (score of 2 out of 7) to very high (score of 7) (Annex 7 'Animal welfare: Hazards and effects on animal welfare'). It should be stressed in this regard that if things do go wrong at the conventional slaughterhouse in relation to stunning/killing this is estimated to be just as severe to the individual animal as it would be at the MSU or in the case of emergency slaughter or euthanasia. However, it is expected that the likelihood of mishaps occurring at the conventional slaughterhouse may be lower due to the environment being entirely designed (space) for the slaughtering process and the entire slaughtering process is conducted in quick succession as opposed to practice in the MSU as well as in emergency slaughter (please see section 5.4. phase C).

In a pilot study of sheep-lambs (Eriksen et al., 2013) slaughtered in a conventional slaughterhouse in Norway or at a mobile slaughterhouse found that animals slaughtered at the conventional slaughterhouse showed more indications of experiencing stress and activity than when slaughtered in a mobile slaughterhouse. Prior to slaughter, the animals vocalised (bleating) more at the conventional slaughterhouse and exhibited more aggressive behaviour (including jumping, which is not necessarily aggression). After slaughter, these animals were also found to have higher levels of the hormone cortisol and lower levels of the sugar molecule glucose in their blood (serum), with a higher meat pH and less tender meat compared to at least 1 mobile slaughterhouse. These results show that there is indeed a difference in terms of animal parameters that may show reduced well-being at a conventional slaughterhouse, despite not all results being equally unambiguous, during the process to slaughter in a conventional slaughterhouse compared to a mobile slaughterhouse. It does not, however, show when this reduced level of well-being took place during this process leading up to slaughter. In addition, the speed of return to basic levels is crucial in order to be able to accurately identify differences between animals and situations (in (Eriksen et al., 2013)). Cortisol levels were also higher for bison at conventional slaughter compared to slaughter at the mobile slaughterhouse (McCorkell et al., 2013).

6. Food safety risk assessment

Internal concerns were raised within the NVWA in connection with the MSU pilot, regarding the potential risks to food safety or animal health. As far as food safety is concerned, the key issue is the fact that all animals supplied to the MSU would actually be high-risk animals given that they are 'sick and injured and suffer from chronic conditions' without slaughtered animals undergoing bacteriological analysis or analysis for residues of veterinary medicinal products (antibiotics, non-steroidal anti-inflammatories)' (Memorandum on MSU considerations of 14/03/19).

6.1. Particulars of MSU in relation to routine slaughter

On the basis of the project protocols available and on BuRO's own observations, the following differences between the working methods of the MSU and routine slaughter have been identified:

1. At slaughterhouses, not all cattle are subjected to temperature checks during the AM inspection.
2. At the MSU, cattle are stuck in a recumbent position. BuRO's own observations show that the relevant methods used in this process may be similar to methods that involve the cutting of the throat form ear to ear (open kop slachten), where the trachea and oesophagus are cut.
3. In the MSU, the knives used to stick the cattle are chemically disinfected.
4. Delayed evisceration following the stunning and bleeding of cattle is inherent to the method used in the MSU.
5. Knives and boots are rinsed above the blood drainage channel, with water from the handwashing station drained to the drainage channel.
6. According to the operator, the blood of the animals slaughter in the MSU is collected as category 1 material, but pumped into a tank for category 3 material at the slaughterhouse and disposed of as such.

Points 1 to 4 constitute potential food safety hazards, with points 5 and 6 being potential animal health hazards.

6.2. Microbiology

In order to identify the possible risk to food safety inherent to the MSU, BuRO first and foremost examined the agents which could lead to disease in humans through the consumption of beef. An EFSA opinion from 2013 was used to this end: *Scientific Opinion on the public health hazards to be covered by inspection of meat (bovine animals)*. This opinion identifies the agents that must be controlled by means of meat inspection (live and slaughtered). To this end, all (both alimentary and non-alimentary) zoonoses able to be transmitted from humans through cattle were identified on a longlist, after which the agents that occur in Europe and which can be transmitted to humans through beef products were selected. Finally, these agents were subjected to a priority ranking in which the agents which are primarily introduced after slaughter and/or of which the growth would be necessary after chilling of the carcass (*Listeria monocytogenes, Bacillus cereus, Clostridium botulinum, Clostridium perfringens and Staphylococcus aureus)* were disregarded. With regard to the remaining agents, which are therefore chiefly introduced in the primary phase of the beef supply chain, the severity of the impact on human health (based on reported incidence), the severity of the disease in humans (based on case fatality rate) and the strength of the evidence that beef is a major risk factor for disease in humans was then determined based on a decision tree. Two agents ultimately remained for which it was concluded that they have high priority status in terms of meat inspection: *Salmonella* and pathogenic *Escherichia coli* (STEC) (EFSA BIOHAZ Panel, 2013). Campylobacter was also assessed as being low priority based on the decision tree, with the effect of the chilling of bovine carcasses on the survival of Campylobacter also playing a key role. *Campylobacter* cells are sensitive to the dehydration of the bovine carcass that occurs during chilling. A study conducted in Ireland and Poland, for example, showed that up to 16% of bovine carcasses were contaminated with Campylobacter before being chilled, whereas the organism could no longer be found after chilling. This effect may explain why beef does not appear to be a major source of human *Campylobacter* infections (EFSA BIOHAZ Panel, 2013). Salmonella and STEC will be discussed briefly in relation to the beef supply chain.

6.2.1. Salmonella

In 2014, Salmonella prevalence in cattle was 9.6% based on faeces analysis. At farm level, the prevalence was 10% in dairy farms. The principal agents of salmonellosis in bovine animals are *S.* Dublin and *S*. Typhimurium (BuRO, 2015). In 2006, 70% of the cases of salmonella investigated by GD Animal Health in dairy farms were caused by *S*. Dublin and 26% were caused by *S*. Typhimurium. Whereas *S*. Dublin is highly adapted to bovine animals and only rarely causes infections in humans, *S*. Typhimurium is also common in other animal species and in humans (Bergevoet et al., 2009) Salmonella infections in cattle are often serious, but frequently also are asymptomatic (Gezondheidsdienst voor Dieren, 2020a).

The percentage of beef tested positive for salmonella by the NVWA is generally low. In 2018, 0.3% of 582 tested samples was positive (in 25g of raw meat) (Vlaanderen et al., 2019). The lower prevalence in the retail phase is an indication that faecal contamination of bovine carcasses in Dutch slaughterhouses is generally controlled (BuRO, 2015). Three percent of human salmonella infections are attributed to bovine animals (Vlaanderen et al., 2019).

6.2.2. STEC

Studies conducted in the Netherlands between 2005 and 2007 showed that STEC O157 is present in 4-5% of dairy cattle herds. Prevalence rates in calves are generally higher than in cattle: in 2008, there was prevalence of 22% for calves and 5% for cattle and 16% and 2% respectively in 2009 (BuRO, 2015). Ruminants, especially cattle and sheep, are the main source of infections for humans. STEC is a commensal bacterium that does not cause any symptoms of disease in the animals themselves (BuRO, 2015).

In 2018, the STEC prevalence rate in samples taken by the NVWA in the retail sector of meat intended for raw consumption and fresh beef was 1.6 and 2.6% respectively. Roughly half of human STEC infections are attributed to cattle as a reservoir (Vlaanderen et al., 2019).

6.2.3. AM inspection

The ante mortem (AM) inspection is used to determine the general health status of animals intended for slaughter. Its purpose is to establish whether the inspected animal exhibits symptoms that could indicate that it is suffering from a condition that may be harmful to human or animal health. If the official veterinarian suspects that an animal intended for slaughter is suffering from a disease that may have a negative impact on human or animal health, it must undergo a thorough examination for a diagnosis to be made (Regulation (EC) No 854/2004). Bovine animals that excrete salmonella or STEC do not (STEC being a commensal bacterium) or do not necessarily (*Salmonella*) exhibit symptoms. Using the current AM inspection procedure, these animals cannot therefore be identified with certainty. The AM inspection can, however, identify animals with clinical symptoms that indicate a systemic disease such as fever, cough, nasal discharge, respiratory difficulties and diarrhoea or other conditions, such as musculoskeletal trauma and inflammation that may indicate the administration of veterinary medicinal products without waiting periods having been observed (EFSA BIOHAZ Panel, 2013).

6.3. MSU procedure

6.3.1. Temperatures of cattle supplied to the MSU

Unlike routine slaughter in a slaughterhouse, where animals intended for slaughter only undergo temperature checks if the supervising veterinarian considers this to be necessary, at the MSU, all animals that are supplied undergo temperature checks as a rule. An elevated temperature may be the result of an infection, inflammation, physiological peculiarities (e.g. partus), stress or environmental factors.
In the MSU pilot, it was agreed that a cow with a deviating temperature (outside the normal value of 38.0-39.0) should not be admitted to the MSU, meaning that the animal may not be slaughtered for human consumption. The intention was to ensure that these animals would be treated or euthanised.

Various sources suggest slightly different values for the normal body temperature of dairy cattle. According to the MSD Veterinary Manual (https://www.msdvetmanual.com/special-subjects/reference-guides/normal-rectal-temperature-ranges), the normal values for the rectal temperature of dairy cattle lie between 38.0 and 39.3 ºC, with Radostits et al., citing 38.6 to 39.5 ºC (cited in: (Suthar et al., 2012)) as normal body temperature. The threshold value for the body temperature of bovine animals that allows healthy animals to be distinguished from animals suffering from an infection is cited as >39.2 and >39.7 (Suthar et al., 2012). 39.5 ºC is also cited as the threshold for an abnormally elevated body temperature in dairy cattle (Service, 2020). Higher body temperatures may be measured in healthy cattle after calving. Vickers et al. report that all cattle for which body temperature was continuously measured over 8 days post-partum reached a body temperature above 39.5 ºC at some stage (Vickers et al., 2010). Suthar et al. also found that the body temperature of dairy cattle post-partum was higher than the normal physiological range (38.6 - 39.5 ºC) (Suthar et al., 2012). Finally, the type of thermometer (up to 0.3 ºC) and the depth of the penetration of the thermometer into the rectum (up to 0.4 ºC) also affect the measured body temperature of cattle (Burfeind et al., 2010).

Risk in relation to emergency slaughter, routine slaughter and euthanasia
Given that cattle undergo routine temperature checks at the MSU, the likelihood of identifying an animal suffering from an elevated body temperature due to disease is greater than in a conventional slaughterhouse or in emergency slaughter. If these animals are subsequently not allowed to be slaughtered for human consumption, this means that there is inherently better risk management in the MSU procedure than in a conventional slaughterhouse setting. The application of 39.0 ºC as a threshold entails an inherent risk that a (small) percentage of animals will wrongly be deemed unfit for slaughter. Salmonellosis is the principal disease entailing potential food safety hazards that will be able to be controlled by using this method. When a bovine animal is euthanised, the cadaver is rendered harmless by its disposal as rendering material. As such, there are no risks to food safety in relation to euthanasia.
Summary
Views on what the normal body temperature range is in dairy cattle, as well as on threshold value indicative of fever, differ between various authors. For that reason, it is difficult to explain that a cow with a measured body temperature of > 39.0 ºC may or may not necessarily be suffering from fever. Although this threshold value is on the conservative side, its use is defensible for food safety purposes.

6.3.2. Sticking of cattle at the MSU

After stunning, cattle at the MSU end up lying down between the barriers in a chest-belly position. Our own observations show that this may result in only one side of the animal's neck being easily accessible for the cutting of the carotid arteries. Because effective bleeding of the slaughtered cow requires the cutting open of both carotid arteries, it is highly likely that a large cut should be applied in such a scenario whereby the trachea and oesophagus are also cut open. The butcher, after all, must also be able to reach the carotid artery situated at the back of the neck with his/her cut. The cutting of the neck will therefore be similar *to religious slaughter, meaning throat slitting from ear to ear*. This method allows the rumen contents to exit through the open oesophagus and lead to contamination of the meat of the cutting point.

The Hygiene Code of the Royal Netherlands Butchers Association (Koninklijke Nederlandse Slagers, KNS) sets out that in relation to the recommended method of sticking that entails a cut from ear to ear the meat that has come into contact with the knife or has inadvertently been contaminated with draining stomach/intestinal contents should be cut away and disposed of as category 2 material.

In addition, it is inevitable that this method of sticking involves cutting through potentially faecally contaminated skin into the muscle tissue of the neck, which is sterile in principle , resulting in the introduction of faecal bacteria, including pathogens. The fact that these are not merely hypothetical risks is demonstrated inter alia by the review by Rhoades et al., which reports that an average STEC prevalence rate of 44% is observed on cattle skin/hide (prevalence rates in individual, reviewed surveys: 7.3 (Ireland) – 76% (US)) and an average salmonella prevalence rate of 60% (prevalence rates in individually reviewed surveys: 15 (US) – 71% (US)) (Rhoades et al., 2009).

Risk in relation to emergency slaughter, routine slaughter and euthanasia
Due to the increased risk of an unfavourable position of the slaughtered animal in the MSU, the MSU method inherently entails a greater risk of contamination of the cutting point. This risk is lower in conventional slaughterhouses, where slaughter does not take place according to religious rites, and in emergency slaughter. It is assumed that in the case of emergency slaughter, the neck of the bovine animal to be slaughtered is generally easily accessible. However, the risk is increased slightly due to the practitioner only occasionally performing an emergency slaughter. When a bovine animal is euthanised, the cadaver is rendered harmless by its disposal as rendering material. As such, there are no risks to food safety.

Summary
During the cutting of the necks of cattle in the MSU, there is a risk that the cutting point may become contaminated with rumen content. Furthermore, it is inevitable that bacteria present on the skin of the neck are introduced into the cutting point through the knife.

6.3.3. Chemical disinfection of knives at the MSU

Slaughterhouses must have facilities for disinfecting tools with hot water supplied at no less than 82ºC or an alternative system having an equivalent effect (Regulation (EC) No 853/2004). According to the available documentation, the knives used at the MSU are chemically disinfected using the agent Kenosan Lactic. As the name would suggest, Kenosan Lactic is a disinfectant based on lactic acid, registered with the Dutch Board for the Authorisation of Plant Protection Products and Biocides (Ctgb) under number 14799N. According to the statutory instructions for use, the agent is inter alia intended for the disinfection of knives in slaughterhouse after thorough cleaning. The action time depends on the concentration used: 2 minutes for an 8% solution and 30 seconds for a 15% solution. The solution must be prepared fresh daily.

According to the Ctgb, the agent is authorised for the control of bacteria (excluding bacterial spores and mycobacteria) and yeasts. This means that the agent is not authorised for the control of viruses.

There are two types of mycobacteria that occur in cattle that may be relevant in the context of food safety. First and foremost, there is *Mycobacterium bovis*, the agent of bovine tuberculosis. *M. bovis* infections in cattle are subject to an obligation of notification and control. The Netherlands has been free of *M. bovis* for decades, which means that there is no circulation among cattle. Occasionally, infected cattle from endemic countries (primarily the UK and Ireland) are imported, which may lead to secondary transmission between cattle stock on a limited scale. *M. bovis* is zoonotic. The main route of transmission to humans is through infected raw milk dairy, where contaminated meat does not act as a vehicle for transmission to humans (EFSA BIOHAZ Panel, 2013). Then there is *Mycobacterium avium* ssp. *paratuberculosis* (MAP), the agent responsible for Johne's disease or paratuberculosis (paraTB) in cattle. The disease is characterised by an incurable chronic infection of the small intestine, with diarrhoea as the principal clinical symptom. ParaTB is endemic in the Netherlands and is considered to be a farm-specific animal disease, meaning that it is not subject to an obligation of notification or control. The possible role of MAP in the development of Crohn's disease in humans has been the subject of debate for decades. However, evidence for this is ambiguous and at present the prevailing view is that MAP should not be considered zoonotic. There is no evidence that meat plays a role in the potential transmission of MAP to humans (EFSA BIOHAZ Panel, 2013).

As far as is known, bovine animals do not harbour any viruses that could pose a hazard to food safety. Nevertheless, for several years, there has been an ongoing debate as to whether the cause of bovine leukosis, a tumour disease that is caused by a retrovirus (bovine leukaemia virus, BLV) is a zoonotic agent. Indeed, in 2015 it was reported that the presence of BLV in human breast tissue samples is significantly associated with breast cancer (Buehring et al., 2015). For the time being, however, there is no conclusive evidence for BLV's zoonotic potential. The Netherlands has been officially free of bovine leukosis (WUR) since 1999.

Risk in relation to emergency slaughter, routine slaughter and euthanasia
Kenosan Lactic is authorised for the disinfection of knives in slaughterhouses, which means that its use is not specific to the MSU. As such, any risks caused by the incorrect preparation or use thereof do not differ between the two categories. It is not known to BuRO what the method is for disinfecting knives in emergency slaughter. When a bovine animal is euthanised, the cadaver is rendered harmless by its disposal as rendering material. As such, there are no risks to food safety.

Summary
At the MSU, knives are chemically disinfected using an agent that is authorised for the control of bacteria and yeasts but not for mycobacteria and viruses – the latter does not, however, mean that lactic acid does not have a virucidal effect. Lactic acid can indeed render inactive a number of enveloped or non-enveloped viruses (Emmoth, 2015).
The use of disinfectants without authorisation for use against mycobacteria for knives at the MSU does not constitute an immediate hazard to food safety, because the agents for which it is not authorised are not transmitted through

meat (*M. bovis*, MAP) or do not circulate among cattle in the Netherlands (*M. bovis*, BLV).
In order to ensure the correct performance of the agent, it is crucial that, in accordance with the regulations, it is prepared, refreshed and is able to act for long enough and that the knives are cleaned for disinfection. This should be included in the company's quality assurance system. Incidentally, whether Kenosan Lactic has a similar effect as 82 ºC water is not automatically demonstrated by the Ctbg authorisation. To this end, a phased test should be established such as outlined in the BuRO *Opinion on the suitability of VR 2827-3 as a disinfectant for slaughter equipment in the meat processing industry* (BuRO, 2019).

6.3.4. Delayed evisceration

The European Regulation 853/2004 requires the evisceration of a slaughtered animal to take place as soon as possible. In the case of emergency slaughter, the same regulation requires that the animal should be chilled if more than two hours elapse between slaughter and arrival at the slaughterhouse – this may be disregarded if weather conditions permit. According to NVWA working regulations, the latter is the case in the event of an ambient temperature of 4 ºC or below. Although the NVWA states that it is the responsibility of the MSU holder to set up the slaughter process in such a way that there are no adverse effects on hygiene and food safety, within the MSU pilot it is generally assumed that evisceration should be carried out within two hours.

Similar initiatives such as the MSU are underway abroad in which periods of 60 (Hessen, Germany; Austria, Styria) and 45 minutes (Switzerland; Germany) are used within which the intestines must be removed. ANSES recommends that delayed evisceration should not exceed one hour in conventional slaughterhouses (ANSES, 2010).

The fear in relation to delayed evisceration is that bacteria, including pathogens, can migrate to the carcass through the intestines. Research has been carried out into this subject in various scientific publications.

When viable bacteria were injected into the intestines of dead guinea pigs (source does not cite numbers), viable bacteria could not be isolated from the carcass if the still-living animal had been exposed to the relevant bacteria in advance. In the same publication, evisceration (removal of the intestines) of 6 skinned sheep carcasses, preserved in a shackled condition at 20 ºC, was postponed for 24 hours after which muscle and lymph node samples were subjected to microbiological analysis without bacterial growth being observed in these samples. The authors concluded that animals are immune to their intestinal microbiota and that this immunity persists after death. As a result, the passage of bacteria through the intestines would not necessarily lead to the presence of live bacteria in the carcass. Delayed evisceration of the intestines up to 24 hours after the animal's death would therefore not lead to contamination of the carcass with intestinal microbiota (Gill et al., 1976).

In an opining article, Berg seems to confirm the view of Gill et al., that the passage of bacteria through the intestinal wall does not necessarily lead to the presence of live bacteria in the carcass, by stating that even in immunocompetent human individuals bacteria continuously move out of the intestines in low numbers, but are killed off by the reticuloendothial system on the way to or in the lymphatic tissue, causing mesenteric lymph nodes and another extraintestinal sites to remain sterile under normal conditions (Berg, 1995).

Gill et al. found that muscle and lymph node samples of 30 lamb carcasses, which had been hung for 24 hours at 20 ºC without having been eviscerated, remained sterile. The same test similarly did not reveal any indications that bacteria were able to pass through the intestinal wall while it remained intact (Gill et al., 1978).

In New Zealand, in three slaughterhouses the effects of technical failures, which led to a delay in evisceration of up to 4 to 5 hours, were subjected to microbiological evaluation. The species of the animals slaughtered was not mentioned. Samples were taken from the abdominal wall or the kidney area of the carcasses using microbiological cotton swabs. In all cases, the colony counts did not deviate from normal values (up to 100,000 cfu/cm^2 in accordance with the Commission Regulation on microbiological criteria 2073/2005): In the 20 carcasses that were eviscerated with a delay of 4 hours, the colony count averaged 2400 cfu/cm^2. In a further 24 carcasses that were eviscerated with a 4 to 5-hour delay, an average colony count of 2400 cfu/cm^2 was measured. Delayed evisceration did, however, lead to contamination of the liver and adjacent tissues with bile. The associated mechanism is cited as being the swelling of the stomach and intestine due to gas formation, which puts pressure on the gallbladder and squeezes bile from the bladder (Gill & Penney, 1982).

In South Africa, the effects of delayed evisceration were examined in 16 white-tailed wildebeest that were shot. The carcasses that were stored individually or in groups at 18 ºC were eviscerated 1.5 hours, 1.75 to 2 hours, 2.75 hours, 3 hours, 3.5 hours and 5 hours after bleeding and samples were taken from the abdominal flap using a punch, with the tissue samples then being subjected to microbiological analysis. The samples of which evisceration had been delayed the longest (5 hours) showed no or no significant microbial growth (< 100 cfu/cm^2), with the non-significant growth being attributed to contamination during sampling. This also applies to a number of cases of non-significant microbial growth and fungal growth in carcasses that were eviscerated sooner. Only the presence of *E. coli* (10 cfu/cm^2) and *Enterococcus durans* (10 cfu/cm^2) in a carcass dressed after 2.75 and 3 hours respectively is seen as an indication of bacterial translocation from the intestines. The author concludes that under the conditions of the test (winter in South Africa) no significant translocation of bacteria from the intestines occurred in the initial hours following the death of the wildebeest (Van Heerden, 2016).

An ANSES opinion from 2010 similarly addressed the issue of the delayed evisceration of animal carcasses and cited possible organoleptic changes in this regard: dull, greyish or brown colouring of the peritoneum (lead-like) accompanied by an unpleasant manure scent resulting from the diffusion of gases from the intestines. In addition, the presence of a significant intestinal convolute, as is always the case in MSU animals, often leads to delayed chilling of muscle tissue, allowing it to acquire a PSE-like (pale soft and exudative) character with a low pH (ANSES, 2010).
ANSES recommends rejection of carcasses if colour or odour abnormalities are detected and adds that conducting microbiological analysis to support the inspection decision, mainly due to low levels of contamination expected at the limit of detection limits, is unlikely to contribute very much.

Risk in relation to emergency slaughter, routine slaughter and euthanasia
In the case of routine slaughter, delayed evisceration of the carcasses of animals for slaughter does not occur, except in the event of technical failures. With regard to emergency slaughter, the European legislator provides a maximum delay period of up to 2 hours before a carcass must be chilled, depending on weather conditions. The frequency of such occurrences is unknown to BuRO. If it is

assumed that cases of emergency slaughter are incidental, it seems plausible that, as a rule, only one carcass is collected for the slaughterhouse without any delay occurring due to the vehicle having to collect slaughtered animals at multiple sites. The MSU method inherently entails delayed evisceration of animals for slaughter, as during a single trip up to six cattle are collected at various establishments. As such, any microbiological risks of delayed evisceration are greater in relation to the MSU than in emergency slaughter or routine slaughter. When a bovine animal is euthanised, the cadaver is rendered harmless by its disposal as rendering material. As such, there are no risks to food safety.

Assessment
The bibliography on the issue of the impact on the microbiological quality of carcasses is relatively limited and is dominated by a single author (Gill). The data indicates that no passive migration of bacteria takes place through the intestinal wall as long as it remains intact. Active translocation of bacteria through the intestinal wall would not lead to the colonisation of extraintestinal tissues after the animal's death, as immunological mechanisms persist after the death of an animal and ensure that no migration of bacteria through the intestinal wall takes place as long as it's intact. BuRO questions the generalisation of findings from a limited number of trials in a limited number of test subjects and animal species. There are physiological differences between animal species and the size of the slaughtered animal affects the rate of the decline of the temperature of the carcass and, as such, affects the growth of bacteria and the rate at which autolytic processes, which also affects the integrity of the intestinal wall, are initiated. In addition, the trials were not carried out under summer conditions. BuRO therefore concludes that no scientific foundations can be given regarding the maximum time between the death of an animal and its evisceration. Neither can it be determined at what ambient temperatures the timely evisceration becomes critical.

In their publication from 1982, Gill & Penney do not discuss the potential microbiological effects of the release of bile (Gill & Penney, 1982), while it may contain several agents that may be relevant to food safety. The bile of cattle has been shown to contain *Salmonella* (Dias et al., 2014), *E. coli* O157:H7 (Jeong et al., 2007) and *Campylobacter jejuni* (Matsumoto et al., 2008).

BuRO considers it reasonable for 2 hours to be maintained as the maximum period between the death of the slaughtered animal and evisceration – as is also the case for emergency slaughter.

6.4. Veterinary medicinal product residues
As is the case with other farm animals, cattle are also given veterinary medicinal products. In such cases, withdrawal periods will apply, depending on the nature of the veterinary medicinal product, in order to prevent consumers from being exposed to residues of veterinary medicinal products derived from the treated animals. Proper use of veterinary medicinal products is monitored by the National Residue Control Plan (Nationaal Plan Residuen, NPR), based on European legislation (Directive No 96/23/EC), which is aimed at monitoring residues, including those of veterinary medicinal products, at the primary stage in live animals. Deviation rates in the NPR are typically low. The principal reason for this is that sampling under the NPR is not carried out on a risk-based. The most recent European overview of inter alia the results of the NPRs of the Member States is the EFSA publication '*Report for 2017 on the results from the monitoring of veterinary medicinal product residues and other substances in live animals and animal products*' (EFSA, 2019).

In connection with the principal reason for cattle to be supplied to the MSU, i.e. lameness, the relevant veterinary medicinal products that could be adminstered are non-steroidal analgesics (NSAIDs), which also lower fever, corticosteroids (anti-inflammatory) and antibiotics. In 2017, at the European level 0.05% of 5,473 cattle samples were non-compliant with regard toNSAIDs, 0.2% of 12,827 samples with regard to corticosteroids and 0.31% of 22,494 samples with regard to antibiotics (EFSA, 2019). In the Netherlands in 2017, no NSAIDs or corticosteroids were found in samples from cattle, however one sample did reveal neomycin and another sample showed gentamycin (2/1882, 0.1%) (EFSA, 2019). In 2018, no samples of cattle in the primary phase were analysed for antibiotic residues under the NPR. One sample of a veal calf (1/1024, 0.1%) tested positive for the corticosteroid dexamethasone in the primary phase. In the slaughterhouse phase, two samples from veal calves tested positive for doxycycline and gentamycin respectively (2/1938, 0.1%) and 5/1377 (0.4%) samples tested positive for NSAIDs (3 x salicylic acid, 1 x diclofenac, all in veal calves and 1 x paracetamol in beef cow) (NVWA, Inspection directorate).

In 2017, the NVWA received warnings that the analgesic paracetamol was being administered to cattle that may not have been fit for transport, in order to mask their unfitness for transport. Out of 10 samples taken by the NVWA from suspect cattle at the beginning of 2018, all meat and urine samples appeared to contain paracetamol. Later that year, during a concerted action, only 5 out of 110 samples tested positive and it was concluded that there was no reason for continuously increased sampling. In respect of this finding, BuRO has found that there is a minimal risk of adverse health effects in humans due to the presence of paracetamol residues (BuRO, 2018).

The available data shows that there is very little to no exposure of the Dutch population to undesirable amounts of chemical contaminants due to the consumption of meat. The intake of prohibited substances and residues of authorised veterinary medicinal products is incidental and the levels of residues established in these incidental cases have always been low, as far as is known (BuRO, 2015).

Risk in relation to emergency slaughter, routine slaughter and euthanasia
There are three reasons why a bovine animal that has reached the end of its production phase (end-of-career animal) could have been given analgesics or anti-inflammatories.

1. To limit unnecessary suffering of the animal until euthanasia
2. To mask lameness to enable transport to slaughter
3. To suppress fever to allow for removal through the MSU

The body temperature of each bovine animal that is supplied to the MSU is measured in the context of the AM inspection. If an animal is suffering from a fever, the animal is rejected access to the MSU. As such, there is a certain incentive to lowering the body temperature of the animal by administering an analgesic to allow for it to be culled through the MSU. Lame animals are not allowed to be transported to the slaughterhouse. If this does occur, the farm of origin of the animals runs the risk of measures being imposed after the animal's arrival at the slaughterhouse. In this scenario there is similarly a certain incentive to administer analgesics – in this case to mask lameness. The extent of the incentive in both scenarios and to what extent livestock farmers actually use veterinary medicinal products to make the condition of the animal intended for slaughter seem more favourable is not known.

The results of the study into veterinary medicinal products from the initial phase of the MSU pilot at the end of 2018-start of 2019 showed no abnormalities. As of December 2019, samples from 15 MSU cattle have so far been analysed for residues of NSAIDs in meat, corticosteroids in the liver and antibiotic residues in the kidneys. Whereas no antibiotic residues and residues of corticosteroids were found, 4 out of 13 cattle analysed for NSAIDs presented positive for paracetamol. Two samples with low levels of paracetamol were taken on the same day as a highly positive sample; cross-contamination at the slaughterhouse cannot be ruled out. A high concentration of paracetamol of 3600 µg/kg was found in one of the samples, which is a factor of 9 higher than the value cited in the paracetamol opinion, which recommend as follows: 'The placing on the market of beef with paracetamol levels greater than 400 µg/kg must be avoided' (BuRO, 2018). The results of the study on corticosteroids (26-1-20) are not yet available. Furthermore, there is the 2017 case in which the NVWA was tipped off about the administration of paracetamol to cattle in order for animals that were unfit for transport to be able to be transported to the slaughterhouse undetected, where all samples that were analysed tested positive for paracetamol. It is suspected that sub-standard farms avoid the MSU (more intensive AM inspection, NVWA attends the establishment). All things considered, it may be that cattle supplied both to the MSU (demonstrated) and to a conventional slaughterhouse (demonstrated) have been given analgesics, anti-inflammatories or antibiotics illegally or without the withdrawal periods having been observed. The likelihood of the latter and the associated (low) risk in terms of food safety is likely the same in both scenarios.

Emergency slaughter is required if an animal is affected by an accident or another type of acute trauma that causes injuries that cannot be cured in farm animals. Although this is not completely out of the question, it is unlikely that an animal that has suffered acute trauma will be given veterinary medicinal products – after all, the 'cure' is to kill the animal. As such, after emergency slaughter the likelihood of veterinary medicinal product residues being present in the carcass is estimated to be lower than for routine slaughter or for animals supplied to the MSU.

Summary
Although the NPR shows that residues of veterinary medicinal products are found in cattle only sporadically, it is conceivable that animals offered for slaughter through the SMU may have been given veterinary medicinal products to reduce fever either illegally or without due observation of withdrawal periods. By carrying out random residue testing for antibiotics, analgesics and corticosteroids and verifying VKI information, three things can be accomplished: a picture can be obtained of the possible extent of the problem, the probability of detection for violations will increase and a signal will be sent to potential offenders.

6.5. Overall food safety conclusions
The relative risks to food safety of the MSU compared to current practice are limited and relate to delayed evisceration, the possible contamination of meat around the neck cut and the potential entering into consumption of meat containing residues of veterinary medicinal products. The risk of residues, of painkillers in particular, is higher, however, it is expected to be equal to or even lower compared to the group of lower quality cull dairy cattle that is disposed of by regular transport. A limited risk means that although there is an increased risk of contamination of the meat with bacteria or an elevated risk of the presence of veterinary medicinal product residues, this does not necessarily lead to a higher risk of disease or increased exposure of consumers of that meat.

7. Animal health risk assessment

Potential risks to animal health are related to biosecurity issues, for example because the MSU enters the housing units of dairy farms to collect animals without thorough cleaning and disinfection of the MSU taking place before attending the next establishment.

In the MSU pilot it was found inter alia that the MSU entered housing units, occasionally up to the infirmary, or that equipment used in the MSU was placed on the ground in the housing unit only to be placed back inside the MSU.

7.1. Vehicles as a medium for the transmission of animal diseases
Although direct contact between infected live animals is seen as one of the key routes for the spread of animal pathogens, various authors inter alia cite the importance of vehicles as a medium for the spread of animal diseases (Troutt et al., 2008; Brennan & Christley, 2012; Mee et al., 2012; Rossi et al., 2017; Kim & Lee, 2018). Actual examples where the spread of an infectious animal disease can be linked to means of transport, however, are scarce. During the tail end of the outbreak of foot-and-mouth disease in the United Kingdom in 2001, meticulous outbreak studies conducted in the field suggested that persistent virus transmission was chiefly maintained mechanically through the movements of contaminated persons and means of transport. Only after Restricted Infected Areas (RIAs) were established, which were subject to a more stringent biosecurity regime, could the virus eventually be eliminated. RIAs were subject to a number of rules, including the obligation to carry out thorough cleaning and disinfection of all means of transport entering or leaving farms (Mansley et al., 2011). The investigation into an outbreak of Bovine Viral Diarrhoea (BVD) in dairy cattle in North Rhein Westphalia in 2012 revealed that the most likely cause for transmission of the virus between two farms had been common use of a slurry truck (Gethmann et al., 2015).

In general, it can be argued that primarily animal diseases that can be transmitted through manure can potentially be spread between establishments through vehicles used for transport (Bovine Alliance on Management and Nutrition, 2001). The biology of these pathogens dictates that they can survive in manure for some time in the absence of the host. Based on expert opinion, salmonellosis and paratuberculosis, and BVD in suckler cows, can be considered to be the principal manure-transmitted animal diseases in the Netherlands (Bergevoet et al., 2010). These diseases are endemic in the Netherlands and will be discussed briefly below. Epidemic diseases, such as foot-and-mouth disease, are not included in this risk assessment.

<u>7.1.1. Salmonellosis</u>
The principal agents of salmonellosis in cattle are *S*. Dublin and *S*. Typhimurium. In 2006, 70% of the cases of *salmonella* investigated by GD Animal Health in dairy farms were caused by *S.* Dublin and 26% were caused by *S.* Typhimurium (BuRO, 2015). In bovine animals, both *S*. Dublin and *S*. Typhimurium may cause fever (up to 41 ºC), diarrhoea, abortion and death, however infections may equally be asymptomatic. Calves up to three months of age are particularly susceptible to salmonella infection. Infected animals will secrete the bacteria in large numbers in their manure for a number of weeks. *Salmonella* is introduced into establishments by visitors, equipment or means of transport. The bacterium is able to survive outside the host for a prolonged period of time, e.g. several months in slurry storage (Gezondheidsdienst voor Dieren, 2020a). In 2014, *salmonella* prevalence in cattle was 9.6% based on faeces analysis. At farm level, the prevalence rate was 10% in dairy farms (BuRO, 2015).
Salmonellosis is subject to an obligation of notification for veterinarians and laboratories.

<u>7.1.2. Paratuberculosis</u>
Paratuberculosis is characterised by an incurable intestinal infection in cattle and other ruminants and is caused by the bacterium *Mycobacterium avium subspecies paratuberculosis* (MAP). The development of the disease is slow and infected

animals will only show symptoms at an age of 3 to 6 years old. Symptoms are initially aspecific. Initial signs are a decrease in an animal's milk yield, followed by deterioration of the animal's condition, despite a healthy appetite, low birth weight of calves and, finally, persistent diarrhoea. Fever is not a symptom of the disease. MAP is primarily secreted by infected animals through their manure. Calves in their first year of life are particularly susceptible to infection. In addition to the supply of infected cattle by other farms, aspects such as tools and equipment, professional visitors and means of transport also play a key role in the introduction of paratuberculosis. MAP can survive in an outdoor environment out of the sun for more than a year (Gezondheidsdienst voor Dieren, 2020b). The paratuberculosis status of virtually all Dutch dairy farms (99%) has been established. Most farms, 75%, have non-suspect status, meaning that no animals with antibodies in their milk have been found in the bi-annual monitoring analyses. Infection is present at 17% of the farms and shedders are culled. Shedders are animals whose milk contains antibodies and manure contains bacteria. A further 2% of establishments held infection present status, where animals whose milk contained antibodies had not yet been culled (Gezondheidsdienst voor Dieren, 2017).

7.1.3. Bovine Viral Diarrhoea

The symptoms of BVD are highly varied and depend inter alia on various animal-based factors, such as fertility status and the presence of co-infections. It is estimated that the majority of acute infections (70 – 90%) is accompanied by mild symptoms. Clinical symptoms vary and may include decrease in production, diarrhoea, abortion and fertility disorders and death. Depending on the stage of gestation at the time of infection, persistently infected 'carrier calves' may be born from pregnant infected cattle, which will secrete large amounts of virus their entire lives. Risk factors for the introduction of BVD at establishments range from the introduction of animals with a lower BVD status to suppliers, such a veterinarians and farm advisers, to veterinary equipment and joint use of livestock transport vehicles with other higher risk farms (Gezondheidsdienst voor Dieren, 2020c). In a specific monitoring survey carried out by GD Animal Health in 2015-2016, recent circulation of the BVD virus was found at 8.7% of dairy farms, with the percentage coming to 14.5% of non-milk supplying establishments (Gezondheidsdienst voor Dieren, 2017).

7.1.4. Cross-contamination of salmonellosis, paratuberculosis and Bovine Viral Diarrhoea through means of transport

Except for BVD (Gethmann et al., 2015), no specific cases were found in which the cross-contamination of salmonellosis or paratuberculosis could be attributed to means of transport for livestock. In the United States, Troutt et al. found *Salmonella* on the floors of livestock trailers that were used to collect cull dairy cattle for slaughter. They concluded that a livestock trailer contaminated with salmonella, that arrives at an establishment constitutes a biosecurity threat to that establishment (Troutt et al., 2008). With regard to paratuberculosis in relation to the 'super shedders' phenomenon, meaning cattle that secrete > 10,000 cfu MAP/g faeces, Fecteau and Whitlock suggest the possibility inter alia that the tyres of vehicles that are contaminated with only a few grams of manure from 'super shedders' may be a potential source of infection to newly born calves (Fecteau & Whitlock, 2010). Sweeney et al. cite one of the options for preventing the infection of calves with paratuberculosis as being the prevention of the infection of veal calf crates with the manure of adult animals, among others, originating from vehicles (Sweeney et al., 2012).

Summary
Given that the MSU visits several establishments per journey, there is a risk that notably the agents of salmonellosis, paratuberculosis and Bovine Viral Diarrhoea could be transmitted from one farm to the next through the vehicle. This risk increases as the vehicle enters the housing unit. The risk can be controlled by prohibiting the MSU from entering housing units, by applying effective cleaning and disinfection procedures primarily for the loading flap, the tyres and wheel arches of the MSU before the vehicle departs to the next farm, as well as use of good personal hygiene. It is vital that a disinfectant is used that works against mycobacteria and viruses.

Risk in relation to emergency slaughter, routine slaughter and euthanasia
In order to be able to compare the risk of cross-contamination of animal diseases through the MSU with that of other parties accessing the farm, knowledge is required of which persons and vehicles may visit a dairy farm on a given day. BuRO is not aware of the availability of such data in the Netherlands. Nöremark et al., however, were able to identify these aspects for establishments with cloven-hoofed animals (cattle, sheep, goats and pigs) in Sweden (Nöremark et al., 2013). On average, an establishment was visited by 0.3 professional and 0.8 private parties each day. Whereas the number of professional parties accessing the farm increased as the herd/flock size increased, this was not the case for private visitors. The average number of visitors per day was highest in summer and in the category of small mixed farms. Artificial insemination technicians, transporters and neighbours often had direct contact with animals, but so too did 9% of repair engineers. Professional visitors were identified as being milk collection vehicles (driver), feed trucks (driver), artificial insemination technicians, repair engineers, veterinarians, rendering vehicles, vendors, animal feed advisers, claw care assistants, inspectors and sampling assistants. Private visitors were identified as being other visits, neighbours, farm shop customers, ramblers and overnight guests (Nöremark et al., 2013). If it is assumed that the situation in Sweden is even somewhat comparable to the Dutch situation, the conclusion, given the diversity of professional and private visitors as well as the frequency of visits, is that (incidental) visits of the MSU to a livestock establishment pose few additional risks in respect of other visitors. This is contingent on proper compliance with hygiene rules. What has been set out for the MSU similarly applies to emergency slaughter and euthanasia. Finally, unlike in regular transport of animals to the slaughterhouse, an NVWA veterinarian is always present at the MSU. Given that an NVWA veterinarian is not usually present at regular transport to slaughter, there may be a higher risk of cross-contamination of animal pathogens under these circumstances.

7.2. Discharge of MSU wastewater into the blood tank
During a working visit to MSU, it was found that knives and boots were being rinsed above the blood drainage channel of the MSU and that the wastewater from the handwashing station also drained into the blood drainage channel. According to the MSU holder, the blood of the animals slaughtered in the MSU is collected as category 1 material, but pumped into a tank for category 3 material at the slaughterhouse and disposed of as such. By law, this method (cat. 1 -> cat 3; please refer to abbreviations and definitions list) is unauthorised. In addition, certain risks may be associated with this method.

The blood of slaughtered animals is in principle considered to be category 3 materials. One of the potential destinations of category 3 material is for use in raw pet food. It is not known whether blood from the MSU actually ends up in raw pet food, however it cannot be ruled out.

The rinsing of boots may potentially allow any manure attached to the boots to end up in the collected blood and for soap residues to end up in the wastewater from the handwashing station. The latter is not expected to be a hazard to pets due to the successive dilutions in the blood storage tank of the MSU, the blood storage tank of the slaughterhouse and the storage tank of the vehicle that collects the blood from the slaughterhouse. In addition, detergents have low toxicity for companion animals (Merck Veterinary Manual, 2020). The manure from boots, however, may introduce pathogens into the collected blood. Due to the degree of contagion to a large number of animal species, it is primarily the possible presence of *salmonella* that constitutes a hazard. A dilution effect will also apply in the case of *salmonella*, however, which, due to the possibility of growth in the blood, will be partially cancelled out. The degree to which this could occur depends on the degree of chilling of the blood in the supply chain from the MSU onwards. In addition to contamination at the MSU, contamination of blood with content from the gastrointestinal tract is also a possibility in relation to other methods of slaughter. Manure particles on the skin of the slaughtered animal, for example, may end up in the blood drainage channel during bleeding,ritual slaughter or similar slaughter involving throat slitting from ear to ear, resulting in rumen content entering the collected blood. The extent to which *Salmonella* in bovine blood constitutes an actual risk to the health of pets cannot be determined in the absence of data on prevalence. There are, however, regular publications on the presence of pathogens, including *Salmonella*, in raw food for companion animals, such as that of Van Bree et al. (van Bree et al., 2018).

Summary
The blood collected in the MSU is contaminated by rinse water and wastewater, resulting in a certain risk of it being contaminated with pathogens. This scenario is undesirable but does not in all likelihood lead to an elevated risk, given that blood in a conventional slaughterhouse setting may also become contaminated with content from the gastrointestinal tract. In addition, the frequency with which the latter occurs is many times greater in the terms of the number of animals slaughtered that in the MSU. The collecting of MSU blood as category 1 material and the disposal thereof a category 3 material is incorrect under the law.

Risk in relation to emergency slaughter, routine slaughter and euthanasia.
Given that no blood is collected in case of emergency slaughter or euthanasia, this hazard is only present in relation to the MSU.

7.3. Overall animal health conclusions
In the field of animal health, there is a risk of cross-contamination of animal diseases as a result of attendance at multiple farms on a single MSU route.

Table 11. Food safety and animal health risks

Stage	**MSU**	**Emergency slaughter**	**Eutha-nasia**	**'High-risk group' standard transport**
Animal health				
Cross-contamination of animal pathogens	Possible	N/A	N/A	Possible
Mixing of wastewater and blood	Standard	N/A	N/A	N/A
Food safety				
Animal temperatures	Standard	If necessary	N/A	N/A
Cutting in recumbent position	Standard	Standard	N/A	N/A
Chemical disinfection of knives	Standard	Unknown	N/A	N/A
Delayed evisceration	Standard	Standard	N/A	N/A
Veterinary medicinal product residues	Possible	Not likely	N/A	Possible

Table 12. Differences in food safety and animal health risks

Hazards	**MSU risks compared to other routes**	**Risks compared to MSU**		
	MSU	**Emergency slaughter**	**Euthanasia**	**Routine transport and slaughterhouse 'high-risk group'**
Animal health				
Cross-contamination of animal pathogens	smaller	Smaller	Smaller	higher
Mixing of wastewater and blood (boots rinse above and drainage of handwashing station to blood drainage channel)	Greater	None	None	None
Food safety				
Sick animal - unfit for slaughter (fever)	Smaller	If necessary	N/A	Greater
Cutting in recumbent position	Greater	Smaller	None	Smaller, only in ritual slaughter
Chemical disinfection of knives	Equal	Unknown	None	Equal
Delayed evisceration	Greater	Smaller	None	None
Veterinary medicinal product residues	Equal	None	None	Equal

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List of abbreviations and definitions

Office for Risk Assessment & Research

Date
25 February 2020

Our reference
TRCVWA/2020/1172

Abbreviations and glossary	Definition
Condition:	'1. a state of sickness'[18]
Acute	'(of diseases) (occurring) suddenly (opposite: chronic (1)): acute appendicitis with rapid progression and severe symptoms'[19]
AM inspection	Ante Mortem (live inspection, before slaughter)
BuRO	Office for Risk Assessment & Research (BuRO), NVWA
Cat 1	Please see TTS C 1 (access to slaughter category 1)
Cat 2	Please see TTS C 2
Cat 3	Please see TTS C 3
Cat 4	Please see TTS C 4
Chronic	'1 (of diseases) lengthy period, protracted, (opposite: acute) 2 continuous, persistent'[20]
GTS	Denied access to slaughter
KDS	The Animal Sector Quality Inspection Foundation or Kwaliteitskeuring Dierlijke Sector, '*The principal activity of KDS consists of making official assistants available to the Netherlands Food and Consumer Product Safety Authority (NVWA) for the conducting of post mortem inspection activities in all Dutch red meat slaughterhouses. In addition, KDS provides sampling services for analysis for Bovine Spongiform Encephalopathy (BSE) in slaughtered cattle.*'[21]
I&R	Identification & Registration
LNV	Ministry of Agriculture, Nature and Food Quality
MSU	Mobile Slaughter Unit; animals that are unfit for transport are killed in the MSU or on the farm, then bled, after which the carcass is transported to the slaughterhouse for further processing.
MS	Mobile Slaughterhouse; animals are killed inside the MS (or at the farm) and bled, after which the carcass is processed within the facility and chilled. NB In practice, or in colloquial terms, MSUs are often (erroneously) referred to as mobile slaughterhouses. The MSU operator, for example, also refers to the MSU as a mobile slaughterhouse. This assessment uses the foregoing definitions, regardless of the terms used by the operator.
Emergency slaughter	Slaughter (outside the slaughterhouse) of an otherwise healthy animal that has suffered an accident and which cannot be transported to the slaughterhouse alive for welfare reasons. In all other cases where an animal is killed outside of the slaughterhouse, this animal will not be eligible for entry to the food chain.
O&D	Design & Services division, Inspection directorate, NVWA ('Ontwerp en Dienstverlening')
UHC	Unfit for Human Consumption.

[18] https://www.vandale.nl/gratis-woordenboek/nederlands/betekenis/aandoening#.XfNcuaJQHRg; most recently consulted 13-12-2019
[19] https://www.vandale.nl/gratis-woordenboek/nederlands/betekenis/acuut#.XfNcY6JQHRg; most recently consulted 13-12-2019
[20] https://www.vandale.nl/gratis-woordenboek/nederlands/betekenis/chronischt#.XfNdQ6JQHRg; most recently consulted 13-12-2019
[21] http://www.bvkds.nl/ http://www.bvkds.nl/

Abbreviations and glossary	Definition
O&O	Development & Support department, Design & Services division, Inspection directorate, NVWA ('Ontwikkeling en Ondersteuning')
Pithing	Damage to the tissue of the central nervous system and the spinal cord with a long and rod-shaped instrument, inserted into the cranial cavity. (Regulation 1099/2009)
PM inspection	Post Mortem inspection
TDA	Official veterinarian, NVWA ('Toezichthoudende dierenarts')
TTS	Access to slaughter ('Toegang tot slacht')
TTS C1	Clinically healthy animal that does not present with any abnormalities at the AM inspection
TTS C2	Clinically healthy animal with externally observable localised abnormalities that do not constitute a risk to the contamination of the slaughter line 1: Udder inflammation without elevated temperature; 2: Infected claw – lower leg; 3: Joint inflammation (excluding inflammation of knee and heel due to problems in the slaughter process).
TTS C3	Clinically healthy animal with externally observable localised abnormalities that may cause contamination during the slaughter process and calves that are part of calf herd of a veal calf farm at which salmonella infection occurred during the fattening period. Inflammation of the knee or heel; one or more visible (not controllable) types of swelling (abscesses); abnormal belly size; inflamed wounds and/or necrosis; straining animal; retained placenta (no fever); recumbent animals or animals with pelvic lameness (partus problems).
TTS C4	A healthy animal that has suffered an accident and which cannot be transported to the slaughterhouse alive for welfare reasons and has been killed at the establishment as a case of emergency slaughter.
UBN	Unique Establishment Number ('Uniek Bedrijfsnummer')

Annexes

Annex Table of contents