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# Import risk assessment for frozen cattle semen from Norway to Iceland

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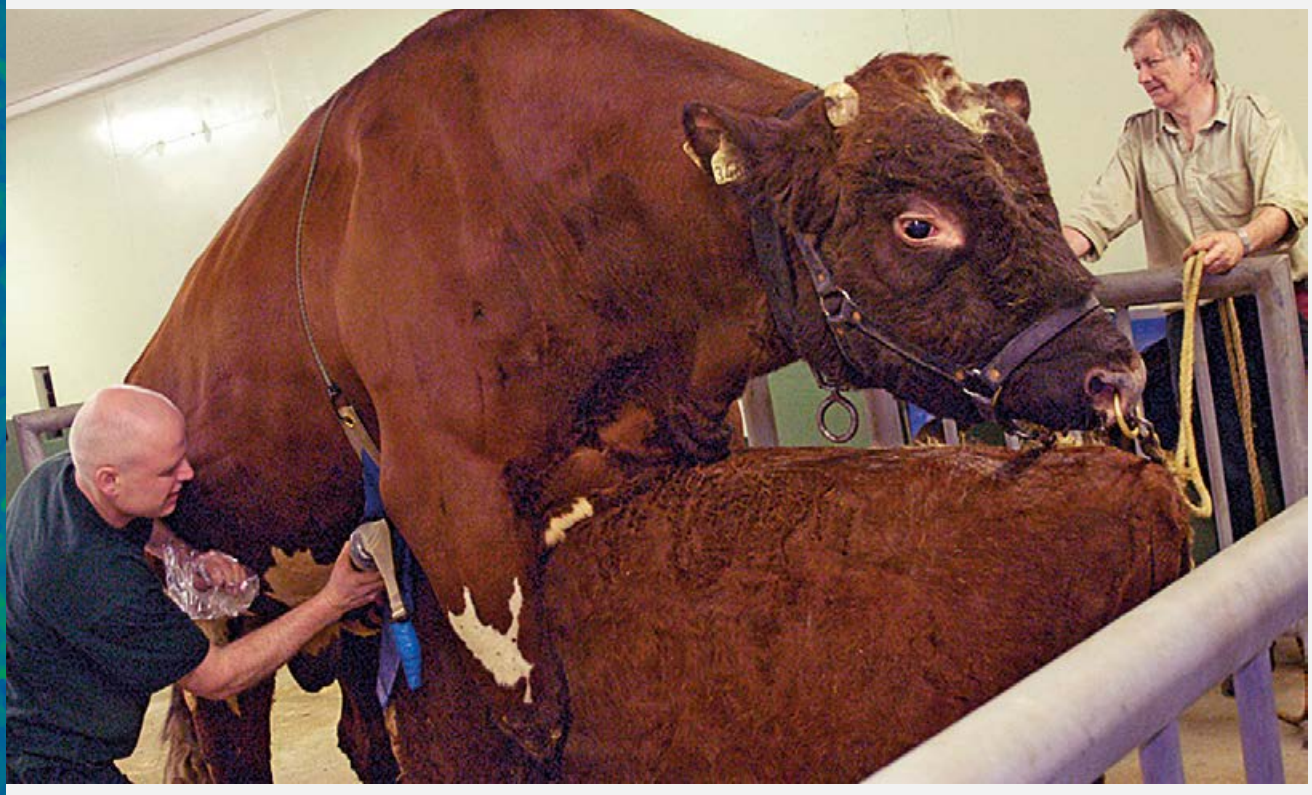

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# Content

## Summary

The present risk assessment estimates the risk related to importing frozen cattle semen from GENO in Norway to all cattle herds in Iceland.

All OIE-listed diseases/infections as well as other major cattle diseases are taken into consideration.

The assessment is based on the OIE guidelines for import risk analysis. The first step is to assess which infectious agents should be considered as hazards. Next, a risk assessment is undertaken for the agents identified as hazards.

Norway is free from all OIE-listed diseases/infections in cattle which can be transmitted through semen, apart from paratuberculosis. The probability of entry of the cattle-strain of *Mycobacterium avium* subsp *paratuberculosis* through imported semen to Iceland is estimated to be negligible to very low. Since the probability that a cow becomes infected, given it's exposed to contaminated semen, is low, we estimate the likelihood that this agent will be introduced into the Icelandic cattle population with imported cattle semen from Norway to be **negligible**.

Among other significant infectious agents, *Salmonella* spp., bovine respiratory syncytialvirus, coronavirus and bovine parainfluenza 3 virus, and *Neospora caninum* are considered as hazards. The likelihood that any of these agents will be introduced into the Icelandic cattle population with imported cattle semen from Norway is estimated to be **negligible**.

# Abbreviations

| | |
|---|---|
| AI | Artificial Insemination |
| AIC | Artificial Insemination Centre |
| AQIS | Australian Quarantine and Inspection Service |
| BCoV | Bovine corona virus |
| BPiV3 | Bovine parainfluensa 3 virus |
| BRSV | Bovine respiratory syncytial virus |
| BSE | Bovine spongiform encephalopathy |
| BVD | Bovine virus diarrhoea |
| EBL | Enzootic bovine leukosis |
| ELISA | Enzyme-linked immunosorbent assay |
| GENO | Breeding and A.I. Association for Norwegian Red (NRF) |
| IBR/IPV | Infectious bovine rhinotracheitis / Infectious pustular vulvovaginitis |
| KLF | Norwegian Independent Meat and Poultry Association |
| KOORIMP | The Norwegian Farmers Advisory Council for the Prevention of Transmittable Import related Animal Diseases |
| MAP | *Mycobacterium avium* subsp. p*aratuberculosis* |
| NC | Neospora caninum |
| NFSA | Norwegian Food Safety Authority |
| NOK | National surveillance and control programmes for terrestrial and aquatic animals in Norway |
| NRF | Norwegian Red, the main dairy breed in Norway |
| NVI | Norwegian Veterinary Institute |
| OIE | Office International des Epizooties (World organisation for Animal Health) |
| PCR | Polymerase chain reaction |
| TYR | The Norwegian Beef breeders Association |

# Introduction

## Background

The National Veterinary Institute was asked by Baldur Helgi Benjamínsson, on behalf of Landssamband kúabænda, Iceland, on 15.12.2013 to make a risk assessment regarding import of cattle semen from GENO Norway to Iceland.

All semen will be frozen before import to Iceland. The semen would be allowed for import to all commercial cattle herds in Iceland.

The following conditions were required of the breeding bulls and their semen:

1. Semen must fulfill all criteria in regulation 88/407/EEC.
2. Semen must have been deep frozen for at least 60 days.
3. Country of origin is free of IBR/IPV.
4. Each ejaculate is tested for IBR/IPV, with negative results.
5. Donor is tested for BVD virus, at least 21 days after collection, with negative results.
6. Each ejaculate is tested for BVD, with negative results.
7. Donor is tested for Schmallenberg virus, with negative results.
8. Donor is tested for Bluetongue with not more than 60 day interval, during the semen collection period, and between 28-60 days after the end of semen collection period.
9. Donor must be tested free of *M. avium* subsp*. paratuberculosis* during semen collection period, and be completely free for brucellosis, tuberculosis, bovine genital campylobacteriosis, trichomoniasis.
10. The country of origin must be free for Vesicular stomatitis, Rinderpest, Contagious bovine pleuropneumonia, Lumpy skin disease, Rift Valley fever.

Point 8 and 9 in the conditions were impossible for GENO to meet. Both points were changed according to GENO's testing regime for the breeding bulls:

8. Donor must be tested for Bluetongue virus before and after the semen collection period with negative results.
9. Donor must be tested free of *M. avium* subsp*. paratuberculosis* before and after the semen collection period, and donor must be free of brucellosis, tuberculosis, bovine genital campylobacteriosis, trichomoniasis.

A preliminary report was to be delivered before March 27th 2014, the annual meeting of Landssamband kúabænda, Iceland.

Landssamband kúabænda did not define any cattle diseases that had to be evaluated in the risk assessment. Therefore the first report, delivered on March 26th 2014, was based on OIE listed cattle diseases. In the present report, non-listed diseases considered as the most relevant by the authors, have been added.

## Method

The assessment is based on the OIE methodology for import risk analysis (OIE 2014).

*Hazard identification*

The hazard identification involves identifying the pathogenic agents which could potentially produce adverse consequences associated with the importation of semen from Norway.

To be identified as a hazard, the pathogenic agent must:

1. be potentially transmitted by the commodity imported (semen), AND

2. be present in the exporting country (Norway), AND

3. if present in the importing country (Iceland), either

    a) there are documented free zones or zones of low prevalence in the importing country

    b) the pathogenic agent is subject to an official control programme in the importing country

    c) there is a more virulent strain in the exporting country

to ensure that import measures are not more trade restrictive than those applied within the country.

*Risk assessment*

For agents identified as hazards, a risk assessment was undertaken, involving the next steps.

Entry assessment

The entry assessment describes the biological pathways necessary for an importation activity to introduce the agent into the country, past the quarantine station, and the probability that this will occur. If the entry assessment demonstrates that there is no significant risk at this stage, the risk assessment process will conclude.

In the present assessment we have considered the pathway depicted in Figure 1. The import of infection into the Icelandic cattle population requires that ALL the following events occur for the same import:

1. The exporting herd is infected, AND
2. The infection is not detected at the time of export, AND
3. The material imported (semen doses) are infected/contaminated. In particular, the agent resists antibiotic treatment, freezing and storage of semen, AND
4. The infection in the imported semen is not detected during the export procedures, AND
5. The pathogen survives transport and enters the country.

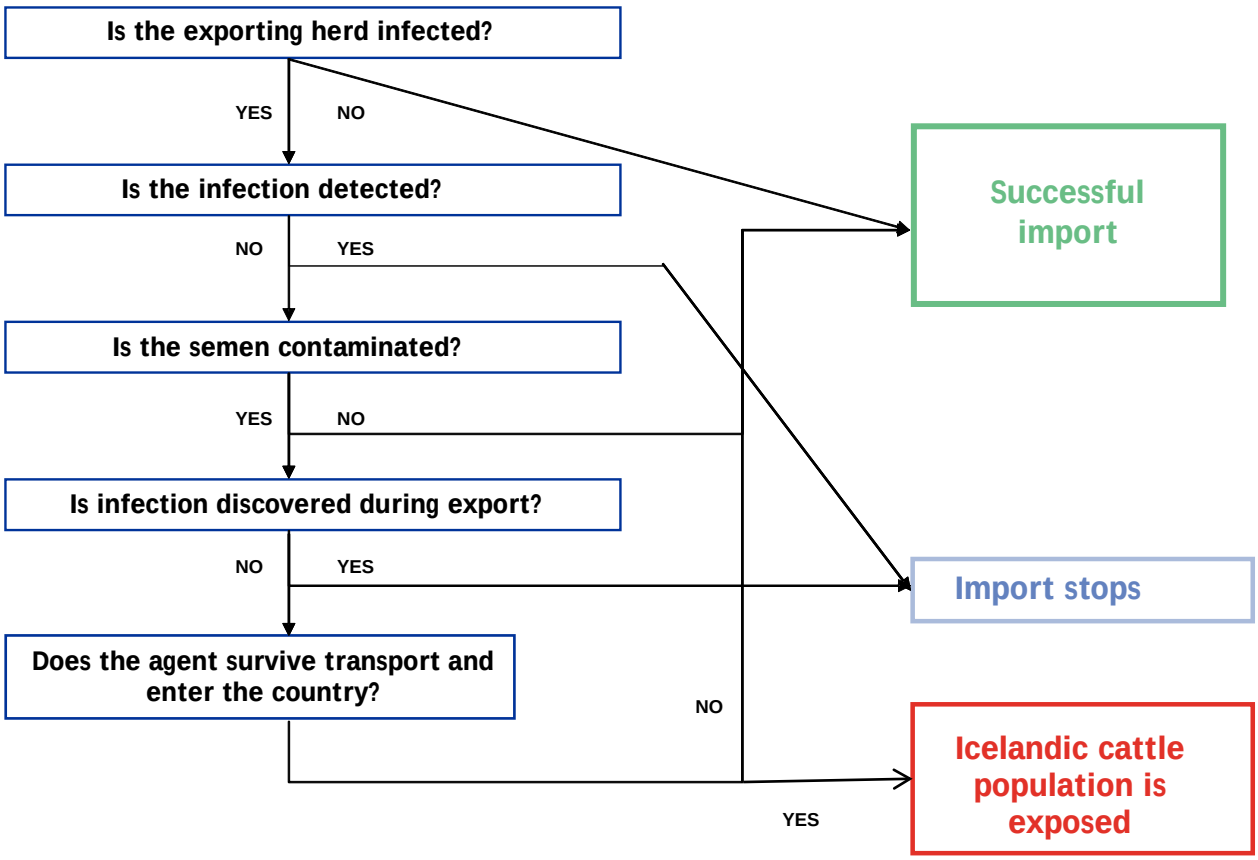


**Figure 1.** Scenario tree used for the entry assessment.

The probability of the different events occurring was estimated based on:

- Biological factors: Susceptibility of cattle to the hazard, expected intra-herd prevalence, transmission routes, infectivity, stability of the hazard, outcome of infection, effect of vaccination of bulls, and of testing and treatment of semen.
- Country factors: Known incidence and/or prevalence of the agent or disease in Norway and in the exporting semen station, historical experience, quality of the surveillance in place - including the capacity to detect the disease with the available diagnostic methods used, risk of importing the agents into Norway, measures in place at the specific exporting semen station, import measures in Iceland.
- Commodity factors: Ease of contamination of semen, production method for semen, effect of freezing, quantity of semen to be imported.

Exposure assessment

The exposure assessment considers whether the Icelandic cattle population would be exposed to the agent if the agent were to be released into the population. If the entry pathway is semen, cows will be exposed. Since the semen is planned to be allowed delivered to all cattle herds, the whole population may be exposed.

Consequence assessment

In the consequence assessment, the possible health, economic, and environmental consequences of an exposure to the agent is assessed.

For semen, transmission of disease requires all following elements:

- the agent is able to cause infection through the veneral route;

- the remaining amount of agent is sufficient to cause infection.

Since the whole population may be exposed, we do not consider further the risk of establishment and spread in the Icelandic population.

**Risk estimation**

Finally, the risk estimation is based on the probability of introducing the disease as well as the magnitude of the consequences.

## Terminology

The terminology used is based on AQIS (2000).

*Definition of terms used for probabilities*

- *High* : Event would be expected to occur.
- *Moderate* : There is less than an even chance of the event occurring.
- *Low* : Event would be unlikely to occur.
- *Very Low* : Event would be very unlikely to occur.
- *Negligible* : Chance of event occurring is so small that it can be ignored in practical terms.

*Definition of terms used for consequences*

- Extreme: consequences associated with the establishment of diseases that would be expected to significantly harm economic performance and/or social well being at a national level. Their effect may continue for an extended period of time. Alternatively or in addition, they may cause serious, irreversible harm to the environment or constitute a serious threat to human health.
- Serious: consequences associated with the establishment of diseases that would have serious biological consequences (eg high mortality or high morbidity with significant pathological changes in affected animals) or social consequences. Such effects may be felt for a prolonged period and may not be amenable to prompt and effective control or eradication. These diseases would be expected to significantly harm economic performance at the level of a major national industry or the equivalent. Alternatively or in addition, they may cause serious harm to the environment or constitute a significant threat to human health.
- Moderate: consequences associated with the establishment of diseases that have less pronounced biological consequences. These diseases may harm economic performance significantly at the level of an enterprise, region or industry sector, but they would not have a significant economic effect at the 'whole industry' level. These diseases may be amenable to control or eradication, albeit at a significant cost or their effects may be temporary. They may affect the environment, but such harm would not be serious or may be reversible.
- Mild: consequences associated with the establishment of diseases that have mild biological consequences and may be amenable to control or eradication. Such diseases would be expected to harm economic performance at the enterprise or regional level but to have negligible significance at the industry level. Effects on the environment would be minor or, if more pronounced, would be temporary.
- Insignificant: consequences associated with the establishment of diseases that have no significant biological consequences, may be transient and/or that are readily amenable to control or eradication. The economic effects would be expected to be low to moderate at an individual enterprise level and insignificant at a regional level. Effects on the environment would be negligible.

### Validity

The present assessment is valid as long as the assumptions made are valid. The risk assessment should be updated if:

- Relevant changes in the health situation occur, both in Iceland and Norway;
- Relevant changes in knowledge occur;
- Any other new relevant information is provided.

It is recommended that the present report is made available to stakeholders for comments during a period of minimum 6 weeks, and that relevant information is taken into consideration. Important stakeholders would be the international scientific community, particularly experts in cattle diseases, the Norwegian and Icelandic cattle industries, as well as governmental organs with specific knowledge about the cattle health situations and impacts. Until this is done, the present report should be considered as a preliminary report.

## The Norwegian cattle industry

### Structure

There were 15 328 cattle herds in Norway in 2013, of which 9 831 dairy herds. The number of dairy herds has been reduced by 28% the last five years while the reduction of the number of cows has been 14% and the total milk production has not significantly changed in the same period. This means that the yearly milk yield per cow has increased by 546 kg since 2007. The breed Norwegian Red is bred for both milk and beef. Most beef is still produced by the Norwegian Red, but the trend is towards more specialized production of either milk or beef. The number of beef herds has been quite stable the last years with about 5000 herds whereas the number of suckler cows has risen from 66 306 to 74 257 in five years. The most common beef breeds in Norway are Aberdeen Angus, Charolais, Hereford, Limousin and Simmental. There are two dairy companies in Norway. TINE is the cooperative company which is nationwide and by far the biggest, with 97 % of the dairy herds as members. Q-Meieriene is the other company which is situated in Rogaland and Oppland counties. Additionally there are some farm stead dairies that make their own cheese and other milk products.
The cooperative meat company, Nortura, accounts for about 70% of the beef production. The remaining 30% is produced by private, independent slaughterhouses organized in a common organisation called Norwegian Independent Meat and Poultry Assosiation (KLF) (Animalia, Statistics 2013).

### Health

OIE-listed diseases

The cattle health situation in Norway in terms of OIE-listed diseases is very favourable.
Anthrax is occasionally expected to be found, but the last verified case in cattle was in 1993. In 2009 bluetongue serotype 8 was diagnosed in four cattle herds in the two most southern counties in Norway. After two years with thorough investigation and surveillance, Norway regained official freedom from bluetongue in 2012. Rabies is endemic on the island of Svalbard, but not in mainland Norway.
One cattle herd is at the moment notified on the basis of paratuberculosis (*Mycobacterium avium* subspecies *paratuberculosis;* MAP), detected in 2010. The last case of bovine virus diarrhea (BVD) was lifted in 2006.
The Norwegian Food Safety Authority (NFSA) carries out 7 surveillance programs in the cattle population according to the OIE list each year. Ten percent of the cattle herds are serologically tested for antibodies against BVDV, enzootic bovine leukosis virus (EBLV) and infectious bovine rhinotracheitis virus / infectious pustular vulvovaginitis virus (IBRV / IPV); 500 dairy herds are tested for antibodies against bluetongue; fecal samples from 50 herds are bacteriologically examined for MAP; 20 000 (2013) cattle are tested for the BSE-agent; and blood from 100 - 150 cows are examined for antibodies against *Brucella abortus*. Examination for *Mycobacterium bovis* is carried out from suspicious organs picked out by the meat inspectors at the abattoirs. Bovine tuberculosis has not been diagnosed since 1986.

Other infectious diseases

*Salmonella* is the 8th surveillance program in cattle herds. No herds are notified due to *Salmonella* spp at the moment. *Salmonella* spp. is, however sporadically detected in one to ten herds annually. The Schmallenberg disease was demonstrated in one malformed calf in 2012. Additionally, 17.4 % of the examined dairy herds (2400) in the southern part of Norway were serolological positive against Schmallenberg virus.

There are still some few herds infected with *Trichophyton verrucosum,* despite great effort done to eradicate this disease.

The most important agents in the cattle industry today are BCoV-infections that cause winter dysentery and respiratory disease and BRSV-infections which cause enzootic respiratory problems, especially in young stock. Calf diarrhoea caused by rota virus or *Cryptosporidum parvum* is quite common in the Norwegian cattle population.

Besides the favourable geographic location of the country, a restrictive attitude to import of live ruminants (see Table 1) has been a key factor to prevent establishment and spread of infectious diseases in Norwegian cattle.

**Table 1.** Imports of ruminants to Norway in the years 1991 to 2013 (Koorimp, 2013)

| Year | Cattle | sheep | goat |
|---|---|---|---|
| **2013** | 30 | 12 | 0 |
| **2012** | 0 | 17 | 0 |
| **2011** | 1 | 39 | 0 |
| **2010** | 0 | 49 | 0 |
| **2009** | 0 | 18 | 0 |
| **2008** | 7 | 0 | 46 |
| **2007** | 31 | 4 * | 5 * |
| **2006** | 8 | 71 | 20 |
| **2005** | 0 | 39 | 53 |
| **2004** | 0 | 11 | 26 |
| **2003** | 19 | 0 | 90 |
| **2002** | 0 | 0 | 33 |
| **2001** | 14 | 0 | 0 |
| **2000** | 48 | 2 | 16 |
| **1999** | 13 | | |
| **1998** | 13 | | 1 |
| **1997** | 101 | | |
| **1996** | 129 | | |
| **1995** | 276 | | 38 |
| **1994** | 375 | | |
| **1993** | 197 | 3 | |
| **1992** | 141 | | 12 |
| **1991** | 89 | | 8 |

* Imports to zoos

# GENO- Biosecurity in the production of semen

## Short description of the animal flow for the bulls in the dairy in GENO

- Around 250 calves are recruited annually from herds over the entire country that are members in Norwegian Dairy Herd Recording Scheme. Recruitment herds are not allowed to have goats on the farms.
- The calves arrive Øyer in Oppland (the first test location) when they are 3 to 5 months (average 135 days) of age.
- For the first two weeks at Øyer the calves are kept in an isolation barn without contact with the other bulls on the farm.

-After selection at Øyer approximately 115 young bulls are moved to quarantine 1 at about 12 months of age. The other bulls are slaughtered.
- After the production of young bull semen the young bulls are moved to the standby bull plant at Store Ree at 16 to 17 months of age. Here they stay for four years until progeny testing is finished.
-The chosen bulls are then moved to quarantine 2 (Elite bull barn) at 5 to 5 1/2 years of age. They are then locked into the elite barn for the production of elite bull semen.
- The bulls then produce semen as long as they are useful for breeding and interesting for the market.

## Governmental regulations that regulate the operation of the facilities

Øyer: Is not subject to any special regulations.
Quarantine 1: FOR 2003-10-06 nr 1242: Regulations on animal health conditions for the production, storage, import and export of bovine semen.
Elite bull barn: All the production of semen by both the young bulls and elite bulls takes place here. FOR 2003-10-06 nr 1242: Regulations on animal health conditions for the production, storage, import and export of bovine semen.
Terrestrial Animal Health Code of the OIE regarding the production of semen and contamination protection: These regulations are not required by the Norwegian authorities, but Geno has chosen to follow the regulations, because many of the customers in the world markets require this.
Standby facility is not subject to any special regulations.
Quarantine 2 FOR 2003-10-06 nr 1242: Regulations on animal health conditions for the production, storage, import and export of bull semen.

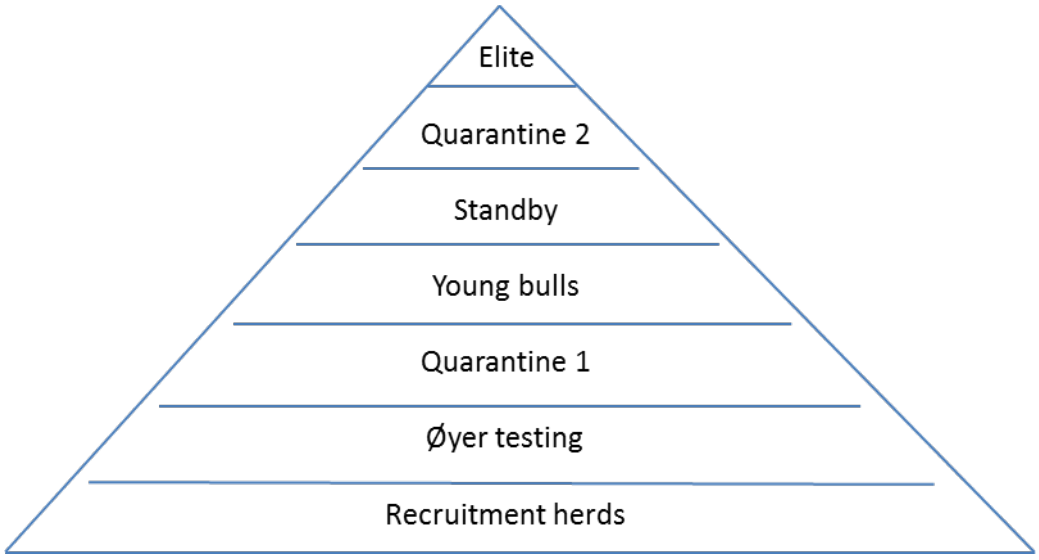


**Figure 2.** The biosecurity pyramid

## Description of the facilities

Øyer is the recipient location of bulls going into Geno's system (NRF and old breeds), while beef bulls are taken to another location (Staur). The testing station was deliberately placed at a distance (> 100 km) from the semen station Store Ree in Stange, near Hamar. Quarantine 1 was established in the late nineties on the farm Store Mæhlum in Gaupen, Ringsaker municipality, about 45 km away from Store Ree and about 60 km from Øyer.
Furthermore, there is Hallsteingård in Trondheim, which has established an enterprise for the freezing of

salmon semen in a laboratory outside the "EU area". Geno has undertaken a modernization of the semen station so it now fulfils EU requirements. This is done to take care of the production of semen of beef bulls on behalf of TYR (Beef Cattle Association). In addition, a few NRF bulls are placed there, primarily due to lack of space at Store Ree. Production of beef bull semen occurs over a period of about 5 months. The production was moved from Store Ree in the nineties. The assessment was that beef bulls gave an additional risk, because they are sold to beef cattle producer after the semen collection period is over. All other bulls (NRF and old breeds) at Geno's semen stations are sent directly from the stations to slaughter. The elite bull barn, the waiting facility and quarantine 2 are all located on the same farm, Store Ree. In 2000, Geno established a system of standby bulls as opposed to the previous system in which 40,000 to 70,000 doses per bull were produced and stored, and the bulls then slaughtered. With regards to this change, a risk assessment of infection hazard by putting young bulls and elite bulls in the same barn, as well as adding quarantine 2 to the elite barn was made.
These localizations are done on the basis of a consideration that, even if all or part of the system should fall within a restricted zone, one should be able to keep a marginal operation and distribution running.

## Requirements for recruitment of calves

Health certificate from the Norwegian Cattle Health Services.
The herd part of the health certificate is the more significant document.
Health certificate will be assessed by a veterinarian at GENO before transport.

## Transport

Individual vehicles and GENO personell carry out the transport. The vehicles are drained and washed before a new trip. GENO considers it important to have control of cars and people. For the transport from Northern Norway GENO uses hired vehicles and drivers. Combined transports with calves and horses are tolerated.

## Testing facilities and animal movements

The facilities are fenced with access control, logbook for visitors, control of feed suppliers, several biosecurity entrance facilities, Isolation facilities where the calves are kept for 14 days. In this period general health examination of the calves, identity control (serological documentation), vaccination against ringworm and respiratory diseases (BRSV, BPiV3 and *Mannheimia haemolytica*) are performed. After two weeks in the isolation facilities the new calves are moved in with the other animals.
Serological analyzes of selected diseases and an intradermal tuberculosis (tbc) test in accordance with the regulations are performed before moving to quarantine 1. In addition GENO voluntarily adds a MAP test and a BVD test. MAP-testing includes bacteriological growth from feces and serological examination with complement fixation test. Blood samples are examined for antibodies against BVDV and BVDV by ELISA-test. Any positive reagents vs tbc, or inconclusive reagents will be further investigated inclusive involvement of the meat inspection.
From Øyer selected young bulls are moved to quarantine 1 which corresponds to a EU quarantine facility. Blood samples from the bulls are taken after 21 days in accordance with regulations. The calves are kept at quarantine 1 for about 40 days before moving to the elite bull barn, Store Ree.
The transport to Store Ree are carried out with own vehicles and personnel. At Store Ree young bulls are kept together with elite bulls. After completing the production of young bull semen the young bulls are moved over to the standby unit using internal transport, to await results of the progeny testing.

## Recruitment of Beef bulls

Geno is operator for TYR regarding production of beef bull semen.
Eighty bull calves are recruited from beef herds all across the country at an age of 5 to 7 months and are transferred to Staur testing station in Stange; Hedmark county. At Staur the calves undergo an examination for selected diseases identical to examined diseases in the NRF calves including MAP, leukosis and BVD. They will also be tested for many different phenotype tests that are basic for the selection criteria. While many of the beef semen bulls are sold to beef producers after the selection or semen collection period, they have to be kept at a different location than Store Ree in the event official

restrictions are put on purchaser herds. As contact herd Staur or Halsteingård may also be put under restrictions. Special emphasis is put on paratuberculosis.

When the different tests and examination at Staur are finished, 15 beef bulls are selected for semen collection. Semen collection and production take place at Halsteingård near Trondheim. The beef semen collection period is 10 weeks, the bulls are thereafter returned to Staur where they are sold. Some of the poorest beef bulls of the ones that are not selected for semen collection are slaughtered, the remaining candidate bulls are sold to beef producers as breeding bulls in the herds.

# The Icelandic cattle Industry

## Structure

There are about 25,000 dairy cows, 1,700 beef cows and in total 72,000 cattle distributed on approximately 800 farms in Iceland (Iceland statistics, 2012). The average number of dairy cows per herd is about 35 cows. Yearly, 21,000 cattle are slaughtered, whereas the volume of beef production has increased from 3600 tons in 2004 to 4,100 tons in 2013. South and Northeast are the areas with the highest density of cattle in Iceland

## Health

Surveillance programmes

The Icelandic Food and Veterinary Authority is responsible for surveillance of the following bovine contagious diseases in 2013: Enzootic bovine leucosis (EBL), infectious bovine rhinotracheitis / infectious pustular vulvovaginitis (IBR / IPV), bovine virus diarrhoea (BVD), *Salmonella* Dublin, Q-fever, bovine brucellosis, bovine spongiforme encephalopathy and paratuberculosis.
In 1933 Iceland imported mædi, paratuberculosis and ovine pulmonary adenocarcinoma with Karakul sheep from Germany (Fridriksdottir et al, 2000). Paratuberculosis together with the other two diseases spread throughout the country and the first clinical case in cattle was confirmed in 1944. Only the sheep strain (Type I) of MAP is found in Iceland (Arnthorsdottir, 2014). This is probably the reason why paratuberculosis in cattle seems to be less virulent than in sheep in Iceland. The last diagnosed cattle herd with MAP was in 2010, while the disease is quite common in the sheep flocks.
In 2012 the authorities found a cattle herd seropositive for IBR, but h*erpes virus I* was not detected.
There are very few OIE-listed diseases present in Iceland, and a limited number of other infectious diseases in the Icelandic cattle population (see Table 2). There are some sporadic cases of listeriosis and a few cases of malignant catarrhal fever mostly based on clinical diagnosis.

**Table 2.** Known occurrence of selected infectious diseases in Iceland (Source: Personal communication from Audur Arnthorsdottir, Icelandic Food and Veterinary Authority)

| | Diagnosed in Iceland | Last year | |
|---|---|---|---|
| **Notifiable diseases** | **the last 5 year (Y/N)** | **diagnosed** | **Comments** |
| Anthrax | No | 2004 | |
| IBR/IPV | Yes | 2012 | Positive serology. Virus not identified. |
| Bovien trichmoniasis | No | | |
| BSE | No | | |
| BVD | No | | |
| Campylobacter fetus subsp. *fetus* | No | | |
| Enzootic bovine leucosis | No | | |
| Leptospirosis | No | | |
| Paratuberculosis | Yes | 2010 | MAP - sheep strain only. |
| Ringworm (*Trichophyton verrucosum*) | No | 2008 | |
| Salmonellosis | No | 2009 | |
| Tuberculosis | No | 1959 | |
| **Other infectious diseases** | | | |
| Blackleg (*Clostridium chauvoei*) | No | | |
| Listeriosis | Yes | ? | Clinical diagnosis. Sporadic. |
| Malignant catarrhal fever | Yes | ? | Clinical diagnosis. Sporadic. |
| *Chlamydophila abortus* | No | | |
| Q-fever | No | | |
| *Anaplasma phagocytophila* | No | | |
| LA MRSA | No | | |
| Rotavirus | ? | | |
| BRSV | No | | |
| Bovine parainfluensa III | ? | | |
| Bovine coronavirus | ? | | |
| *Haemophilus somnus* | No | | |
| *Mycoplasma bovis* | No | | |

# Hazard identification

This part identifies whether the diseases or agents of concern are hazards, i.e. could potentially produce adverse consequences to Iceland, when importing cattle semen from Norway.

## OIE-listed diseases

Table 3 lists all OIE-listed disease/infections that can be found in cattle. For each disease/infection, we report if it is present in Norway, in Iceland, and may be found in cattle semen. According to this classification, most agents causing these diseases/infections can be excluded as hazards.

The reason why MAP is classified as a hazard despite being present in Iceland, is that the bovine strain found only in Norway could be more pathogenic to cattle than the sheep strain found in Iceland.

**Table 3**. Hazard identification for import of cattle semen from Norway to Iceland, OIE-listed diseases.

| Diseases of Bovidae | Present in Norway | Present in semen | May be present in Norwegian semen | Present in Iceland | Hazard? |
|---|---|---|---|---|---|
| **OIE listed, multiple species** | | | | | |
| **Anthrax** | Yes | No | No | No(last in 2004) | No |
| **Bluetongue** | No (since 2012) | Yes | No | No | No |
| **Brucella abortus** | No | Yes | No | No | No |
| **Crimean Congo haemorrhagic fever** | No | (Yes) | No | No | No |
| **Epizootic haemorrhagic disease** | No | Yes | No | No | No |
| **Fout and mouth disease** | No | Yes | No | No | No |
| **Heartwater** | No | (No) | No | No | No |
| **Infection with Aujeszky disease virus** | No | Yes | No | No | No |
| **Infection with rabies virus** | No | No | No | No | No |
| **Infection with rinderpest virus** | No | Yes | No | No | No |
| **New world screwworm** | No | No | No | No | No |
| **Old worls screwworm** | No | No | No | No | No |
| **Paratuberculosis** | Yes? (last 2010) | Yes | Yes | Yes | Yes |
| **Q fever** | No | Yes | No | No | No |
| **Rift valley fever** | No | Yes | No | No | No |
| **Surra** | No | (No) | No | No | No |
| **Vesikular stomatitis** | No | Yes | No | No | No |
| | | | | | |
| **OIE listed, Bovidae** | | | | | |
| **Bovine anaplasmosis** | Yes | No | No | No | No |
| **Bovine babesiosis** | Yes | No | No | No | No |
| **Bovine genital campylobacteriosis** | No | Yes | No | No | No |
| **BSE** | No | No | No | No | No |
| **Bovine tuberculosis** | No | Yes | No | No | No |
| **Bovine viral diarrhea** | No | Yes | No | No | No |
| **Enzootic bovine leukosis** | No | Yes | No | No | No |
| **Haemorrhagic septicemia** | No | No | No | No | No |
| **Infectious bovine rhinotracheitis/ infectious pustular vulvovaginaitis** | No | Yes | No | Yes | No |
| **Infection with Mycoplasma mycoides subsp. Mycoides SC (CBPP)** | No | Yes | No | No | No |
| **Lumpy skin disease** | No | Yes | No | No | No |
| **Theileriosis** | No | ? | No | No | No |
| **Trichomoniasis** | No | Yes | No | No | No |
| **Trypanosomis (tsetse-transmitted)** | No | ? | No | No | No |

### Paratuberculosis

Paratuberculosis is a chronic infection in the intestine of ruminants caused by *Mycobacterium avium* subsp. p*aratuberculosis* (MAP). The bacterium grows very slowly, and clinical disease can't be detected before the animal has become two years of age. The fecal-oral route shortly after birth is the main transmission route. MAP is detected in many organs in infected cattle, including reproductive organs and semen.

There are two main strain types of MAP, the sheep (S) and the cattle (C) type. Further, four subtypes of the S strain and nine subtypes of the C-strain can be differentiated.

Paratuberculosis is a notifiable list B disease and was considered to be endemic in the goat population in six out of the 19 counties in Norway (Kampen et al, 2014). In 2004, the dairy industry (TINE) and the Norwegian Goat Health Services started a campaign to eradicate three contagious diseases, including paratuberculosis, from the goat population. In 2013, there were only 11 dairy goat herds that had not carried out the eradication programme for MAP. Since 1996, the disease has been diagnosed in 10 cattle herds, six sheep flocks and 34 goat herds. The last cattle herd was discovered in 2010. All cases among cattle are attributed to one of two reasons; through import of cattle (seven herds), or through contact

with infected goats (three herds). There has been very little import of live cattle the last 16 years (in total 174 cattle) and import of live animals has been replaced by semen and embryos. Thus, the sources of indigenous infection of MAP have been goat herds and to a small extent sheep herds.
In Norway there has been a surveillance programme for paratuberculosis since 1996 with main focus on the goat population, while approximately 50 cattle herds have been examined every year with fecal samples from 5 individual animals in each herd (Kampen et al., 2014).
GENO has also a focus on the disease and the candidates that are recruited for breeding are tested for MAP two times before the first semen collection (at Øyer and at the Quarantine 1) and two times a year for the elite bulls.

**Summary:**

- Paratuberculosis is a hazard because the C-strain MAP has been found in Norwegian cattle in rare occasions the last 20 years, the last time in 2010 (one cow). It can therefore not be excluded that it's present in Norway. MAP may furthermore be transmitted with frozen semen. The Icelandic cattle population is infected with the S–strain of MAP whereas the Norwegian ruminant population is infected with the C-strain.

## Non-OIE listed diseases

Table 4 lists a selection of non OIE-listed diseases/infections that can be found in cattle. For each disease/infection, we report if it is present in Norway and not in Iceland, and may be found in cattle semen. According to this classification, most agents causing these diseases/infections can be excluded as hazards.

It is doubtful if the respiratory agents mentioned here are present in semen, but the agents are well distributed in the Norwegian cattle population and a possible contamination of semen from the environment cannot be excluded.

Table 4. Hazard identification for significant non-OIE-listed diseases of cattle.

| Diseases of Bovidae | Present in Norway | Present in semen | May be present in Norwegian semen | Present in Iceland | Hazard? | Comments |
|---|---|---|---|---|---|---|
| *Anaplasma phagocytophila* | Yes | No | No | No | No | |
| *Clostridium chauvoie (blackleg)* | Yes | No | No | No | No | |
| Bovine coronavirus | Yes | Yes? | Yes? | ? | Yes | |
| Bovine respiratory syncytial virus (BRSV) | Yes | Yes? | Yes? | No | Yes | |
| *Chlamydophila abortus* | No | Yes | No | No | No | |
| *Haemophilus somnus* | Yes | Yes | Yes? | Yes | No | Obligate parasite of the upper resp. and the lower genital tract |
| *Leptospira interrogans* | No | Yes | No | No | No | |
| *Listeria monocytogenes* | Yes | Yes | Yes | Yes | No | |
| Malignant catarrhal fever | Yes | Yes? | Yes | Yes | No | |
| Meticillinresistant *S. aureus* (MRSA) | No | Yes | No | No | No | |
| *Mycoplasma bovis* | No | Yes | No | No | No | |
| *Neospora canunum* | Yes | Yes | Yes | ? | Yes | |
| Bovine parainfluensa III virus | Yes | Yes? | Yes? | ? | Yes | |
| Rotavirus | Yes | No | No | ? | No | |
| *Trichophyton verrucosum* (ringworm) | yes | No | No | No | No | |
| *Salmonella* spp | yes | Yes | Yes | No | Yes | |

***Salmonella* spp.**

*Salmonella (S)* in cattle affects mainly the calves, often with serious and deadly symptoms. Also adult cattle get infected and may show diarrhoea as the main symptom.Cattle infected with especially *S.* Dublin may become lifelong carriers (Radostits, 2007).
Different serotypes of *Salmonella* spp are sporadically diagnosed in cattle herds in Norway. The incidence is very low, usually ie from zero to three herds are detected herds each year. 2011 was an unusual year with 11 cattle herds infected with *Salmonella.* Relatively many poultry- and swine herds were infected too

in 2011. The infection with *S.* Typhimurium is endemic in the wild bird population and in hedgehogs. Thus, they may constitute a source for the farm animal. The production of concentrates is regularly tested for contamination of *Salmonella* and all concentrates for cattle are heated to 81C° (Regulation, FOR-2002-11-07-1290 ). *S.* Typhimurium is the most frequent serovar in Norway and in a few cases the multiple antibiotic resistant phage types *S.* Typhimurium DT 104 and monophasic *S.* Typhimurium have been detected. *Salmonella* Dublin is very seldom diagnosed;last time was in 2007 when the serovar was found in two cattle herds.
A surveillance program for *Salmonella* in cattle was established in 1995. Lymph nodes from approximately 3000 slaughtered cattle are examined every year. The average prevalence of positive individuals is far below 0.2%. In 2013, the estimated prevalence of positive animals at the individual carcass level was 0.03% (one positive case detected) (Heier et al 2014).
*Salmonella* can be found in the semen of the bulls either in animals with bacteraemia or more common because of contamination with faeces especially from bulls with diarrhoea caused by *Salmonella* infection. Some of the serovara may be multidrug resistant. Thus, the mixture of four antibiotics added to the semen is not sufficient to prevent a possibility to transmit *Salmonella* through semen (MAF, 2009). The oral route is the main entrance into the body, but infected semen could provide intrauterine infection and more seldom septicaemia. However, the uterus of cows in oestrus has a very efficient immune system against infections (Arthur et al. 6$^{th}$ ed.), which would prevent systemic infections in most cases.

In summary, the cattle populations in Norway and Iceland are both exposed to a number of serotypes, through humans and the environment, including wild birds. Some of these have been found in Norwegian cattle but so far not in Icelandic cattle. The cattle adapted serovar *S.* Dublin, which is favoured with a surveillance program in Iceland, has been detected in two Norwegian cattle herds during the last 10 years. Therefore, we included *Salmonella* spp. as a hazard, although it may be considered as a borderline agent.

**Bovine respiratory syncytial virus (BRSV)**

Bovine respiratory syncytial virus is widely spread around the world. It is also widespread in Norway, but never found in Iceland. It is therefore considered a hazard.
BRSV is one of the most important causes of respiratory disease in young calves. However, also adult cattle can become clinically affected. The virus is often associated with severe epizootics of respiratory disease in bothdairy and beef cattle herds. BRSV causes infections in the lower respiratory tract and interstitial pneumonia especially in the front part of the lungs. A viremic phase has not been reported and the virus is fragile and has a short survival outside the respiratory system (Larsen, 2000). Normally the infected animals shed virus for a short period time, but latent infected calves may play a role in the epidemiology of the disease (Klem et al., 2013, Sarmiento-Silva et al, 2012). However, virus transmission from latent infected calves to susceptible calves has never been proven (Valarcher et al, 2006). The transmission occurs by direct contact between animals or by aerosols. Passive spread of the infection by humans or various equipment may be possible. Infection of semen with BRSV is not proved.
BRSV is one of the most important respiratory agents in cattle worldwide. In Norway the first diagnosed outbreak of BRSV was in 1976. BRSV together with BCoV and BPiV3 are the most important respiratory infections in cattle.A sero survey from 2007, demonstrated 71% positive cattle herds (Gulliksen et al, 2009). A recent sero-survey of BRSV in young cattle (150 – 365 days old) in Norway found the proportion of seropositive herds to be 54% (Klem et al., 2013).
The testing facility at Øyer has occasionally had outbreaks of respiratory disease in the population of calves caused by BRSV.

In summary, BRSV is a very common disease in Norway and it causes a lot of harm to the Norwegian cattle population. It is not diagnosed in the Icelandic cattle population. It is questionable if the agent could transmit the semen either inside the body or from the environment. We have not found evidence in the literature that BRSV transmits through semen, but we have chosen to include the agent as a hazard since there may be very small possibility that it could.

**Bovine corona virus**

Bovine corona virus (BCoV) is a pneumoenteric virus that causes diarrhoea in young calves, winter dysentery (WD) with hemorrhagic diarrhoea and drop in milk yield in adult cattle, and bovine respiratory disease in cattle at different ages (Saif, 2010). BCoV infects the tissue in the upper and lower respiratory tract and the intestine. An infection may cause a short viremic phase. BCoV is very contagious, thus the virus is easily transmitted between herds by animals, people or fomites. To date it has not been possible to distinguish between the virus that cause respiratory disease and enteritis. However, there are revealed

2-3 subtypes of the virus and systematic genetic differences between respiratory type and enteric type have been described. The virus is shed in faeces, orally, in nasal discharge and ocular fluid. In experimental studies the virus shedding has lasted for five days on average, but could be 14 days under stress conditions. Healthy cows could shed the virus, but it is not known if they are subclinical or persistent infected. Reoccurrence of WD in the same individual is possible. Outbreaks of WD in the same herd could happen in interval of 2 – 4 years (Radostits et al, 10. Ed.). By low temperatures the virus may be infectious for a longer period, while by 20 °C in dry environment the virus survive for few hours (Mullis et al. 2012).
The respiratory symptoms are mild with coughing and rhinitis and cows with winter dysentery can often have mild respiratory symptoms simultaneously. Bacterial co-infections may worsen the clinical symptoms. Bovine corona virus is distributed world vide in the cattle population and the virus is also diagnosed the wild ruminant population in some countries. In Norway, the prevalence of seropositive BcoV cattle herds is estimated to be 81%, and 39% seropositive among individual calves (Gulliksen et al., 2009)
Because BCoV has a short viremic phase an infection of the semen through the reproductive organs cannot be excluded and a contamination from the faeces or the environment is also possible.

In summary, BCoV is widely distributed in Norway, but is not detected in Iceland. The disease spreads easily between herds and the virus has the capability to survive some period in the environment under optimal conditions. Therefore, there is a small possibility that the semen could both be infected through the reproductive organs and contaminated from the faeces / environment. The agent is included as a hazard.

**Bovine parainfluensa 3 virus**

Bovine parainfluensa 3 virus (BPiV3) is a paramyxovirus that may give infections in the respiratory organs of cattle. In naïve calves the virus can lead to fever, coughing, rhinitis, bronchitis and pneumonia. The virus is shed in nasal discharge and aerosols (Ellis, 2010). In some cases the infection leads to a short viremiea. The virus is also found in faeces of sick calves, but virus-transmission through infected feces to susceptible animals is not known. In adult cattle the infection is mainly subclinical. It is discussed to which extend BPiV3 causes clinical disease alone, because the virus often occur together with BRSV or BCoV. Thus, it is difficult under natural conditions to attribute the clinical symptoms to one agent. Stress-situations like transportation may initiate disease in cattle, but normally the condition last for a short period of time.
Like BRSV and BCoV, BPiV3 exists all over the world. In Norway, the prevalence of antibodies against BPiV3 was 90% at the herd level and 50 % among individual calves (Gulliksen et al., 2009).

Contamination from the environment is the most likely mechanism for transmission to semen.

In summary, BPiV3 is one of three viruses that may cause respiratory disease in Norwegian cattle. BPiV3 is probably most important as a co-infection together with BRSV or BCoV or as a preceding infection for more serious bacterial respiratory diseases. The agent is not diagnosed in Iceland. Thus, we have included BPiV3 as a hazard.

***Neospora caninum***

*Neospora caninum* (NC) is an intracellular protozoan parasite that infects dogs and cattle. The dog is definitive host whereas cattle are one of the intermediate hosts. The main symptoms in cattle are abortions or malformations of foetuses. Abortion occurs normally in 5 – 10% of pregnant cows when it comes to epizootic incidences, even though much higher figures are demonstrated in some outbreaks. Cattle get infected either from intake of oocytes from the faeces of dogs or through transplacental infection from the dam to her offspring. Transplacental infection is the major route of infection (Radostits et al, 10 ed.). ie Most of the infected calves are born normal. The transplacental route seems to give only sporadic abortions in affected herds whereas ingestion of oocytes from infected dogs can give outbreaks of abortions. In cattle, the infection is lifelong, thus cows can have repeated abortions in subsequent pregnancies.
Neospora caninum has a worldwide distribution. In Norway, the prevalence of seropositive herds was 0.7%, but there were regional differences with the highest prevalence in Østfold county with 2.8% positive herds (Klevar et al, 2010). In comparison, the herd prevalence in dairy cows in Sweden was 8.3% (Frössling et al., 2008).
The semen of infected bulls contains NC tachyzoites (asexual reproduction) that could cause intra uterine infections in cows. Trials have been carried out where NC tachyzoites in different concentrations are added to semen used for insemination of cows. These trials have shown that cows must be inoculated with

at least 5000 to 50000 tachyzoites to provide a permanent immune response in the cow (Serrano-Martínez et al., 2006). The parasite tolerates freezing to -196 °C. The maximum parasite load observed in semen from natural infected bulls was 10/ml. In an ejaculate there are approximately 100 tachyzoites. By repeated natural mating an infectious dose could possibly be achieved. It is also claimed that intracellular tachozoites (in leukocytes) survive better in uterus than free tachyzoites. Thus, the infectious dose could be less than 5000. Different studies dealt with transmission of NC in cattle through semen and artificial insemination has not given a clear conclusion if this possible route of infection represents a true risk.

In summary, NC exists in the Norwegian cattle population to very low extent whereas the agent is probably absent in the Icelandic cattle population. The contagion is to be found in bovine semen, but it is not proven if the infected semen could transfer the infection to a susceptible cow. We consider this agent as a hazard.

# Risk assessment

The present chapter assesses the risk of importing hazards through cattle semen from Norway to Iceland. The assumption is that the semen is imported from GENO's AIC, Hallsteingård.

The introduction of hazards into the Icelandic ruminant population requires that the different steps mentioned in the scenario tree (fig 1) all occur. The probability of each of these steps is evaluated separately, assuming that the precedent steps have occurred. The conclusions of these evaluated steps are shown for each hazard.

**OIE-listed diseases**

## Paratuberculosis

The probability that Store Ree or Hallsteingård should be infected through infected young bulls from beef herds in Norway is very low since the prevalence of paratuberculosis in the cattle population is considered to be very low (10 herds found positive since 1996). Paratuberculosis is on the B-list of notifiable diseases. Thus, the authorities and the veterinary practitioners are aware of the disease. A surveillance program has been established since 1996, albeit a small program, but partly a targeted program in risk populations. Imports of cattle and small ruminants have been very restricted. Imported ruminants are quarantined and tested up to three times for MAP during the quarantine period, with both bacteriology from faeces and serological testing (ELISA).

The dairy bulls are tested for MAP (ELISA) twice before entering Hallsteingård. The beef bulls are tested once before young bull semen production. The elite bulls are thereafter tested twice a year during the production period. The likelihood that an infection would remain undetected before semen collection, is considered to be low.

Semen from MAP-infected bulls including the different male reproduction organs may be infected with the bacteria (Radostits, 10$^{th}$ ed, Ayele et al. 2004, Khol et al 2010, Münster et al 2013). It is less likely that semen from subclinically infected bulls are infected compared to clinical infections. However, the proportion of infected bulls that have MAP contaminated semen is not known. More sensitive detection methods like PCR have increased that proportion.

Frozen bovine semen that is approved for use will not be tested for MAP. If the semen contains MAP it will not be discovered. A mixture of four different antibiotics is added to the semen (streptomycin, penicillin, lincomycin, spectinomycin). Neither the freezing process nor the antibiotics added prevent MAP from surviving in the semen.

Some experiments with cows in oestrus that have been inoculated intra uterine with MAP simultaneously with insemination have shown that the cows eliminated the bacteria in uterus and didn't develop systemic

infection (Radostits, 10th ed). Other challenge trials with MAP inoculated in uterus detected MAP in uterus several weeks after inoculation and MAP was found in lymph nodes in the abdomen (Whittington et al 2009).

When a cow becomes infected with MAP through contaminated semen, the infection will probably not be detected until the cow eventually shows clinical symptoms, or is identified through active surveillance of recipient cows. The disease will therefore be able to spread further in the population, and be difficult to eradicate. Surveillance is in place due to the sheep-strain, and would also identify the cattle-strain. The cattle-strain may however cause more serious disease in cattle.

Table 5. Likelihood of each step necessary to import MAP with frozen semen.

| SEMEN | Likelihood | Comments |
|---|---|---|
| Is the AIC infected? | Very low | Prevalence in the cattle population is very low in Norway. Notifiable disease. Surveillance programme since 1996. The bulls are tested when kept in the quarantine |
| Is the infection undetected? | Low | All candidate bulls are tested twice before becoming a breeding bull. The breeding bulls are tested twice a year. |
| Is the semen from infected bulls contaminated? | High | MAP in the semen of subclinical infected bulls is quite frequently detected. Antibiotics don't inactivate MAP. |
| Is infected semen undetected during export? | High | No testing. |
| Does infected semen cause infection in the cow? | Low | Inoculation of small doses of MAP intra uterine in cows simultaneously with insemination has not led to systemic infection |
| May the infection spread further before it is discovered? | High | Challenging diagnosis, indirect transmission through the environment |

**Conclusion**

The probability of entry of the cattle-strain of *Mycobacterium avium* subsp *paratuberculosis* through imported semen to Iceland is estimated to be negligible to very low. Since the probability that a cow becomes infected, given it's exposed to contaminated semen, is low, we estimate the probability of entry and infection to be negligible.

The consequences are therefore not considered.

**Non-OIE listed diseases**

## *Salmonella spp.*

*Salmonellosis* is a notifiable disease in Norway and *Salmonella* is an important zoonosis. Therefore it is always great focus on the agent. A comprehensive surveillance program has been established since 1995. The prevalence of *Salmonella* infections in the Norwegian cattle population is very low. The likelihood that an elite bull is infected with *Salmonella spp.* is therefore very low.

A calf subclinically infected with *Salmonella* may show clinical symptoms when arriving at Øyer after being stressed by transportation and change in environment. Also, it may transmit the infection to other calves in the barn that will show symptoms. All the individuals undergo a thorough clinical examination and they are clinically monitored every day by the personnel at Øyer. Salmonella infection is therefore likely to be detected.

If the bull is infected, the semen may be contaminated only during bacteraemia. More likely, the semen may be contaminated from faeces or from the environment. However, the semen is added four different antibiotics (penicillin, streptomycin, lincomycin, spectinomycin) that will destroy most of the strains we have in Norway. The survival of some rare resistant strains cannot be excluded, but the likelihood is very low.

Semen that is contaminated with *Salmonella* will not be detected during export because there is no testing of the semen after it is sent to Iceland.

Cows inseminated with contaminated semen will be exposed to *Salmonella*, but the likelihood of infection is considered to be low to very low based on the relatively low infection dose and the elevated immunity in the uterus during oestrus.

Cows infected with *Salmonella* could become clinically ill with systemic signs or they could be locally infected in uterus with reproductive disorder or abortion. The probability that the infection in the cows will be detected is low to moderate especially with only local infection.

Table 6. Likelihood of each step necessary to import *Salmonella* with frozen semen.

| SEMEN | Likelihood | Comments |
|---|---|---|
| Is the AIC infected? | Very low | Very low prevalence in the cattle population in Norway. Notifiable disease. Surveillance programme since 1995. |
| Is the infection undetected? | Low | Repeatedly clinical examination of all bull calves and young bulls at the testing station and the AIC. Great focus on diarrhoea in AI-bull population. |
| Is the semen from infected bulls contaminated? | Very low | Few AB-resistant subtypes detected thus AB additive to the semen will kill most of the strains. |
| Is infected semen undetected during export? | High | No testing. |
| Does infected semen cause infection in the cow? | Low | The infections dosage is relatively low. Cows in oestrus have an effective infection barrier in the uterus |
| Is infected cow undetected after insemination? | Moderate | No quarantine. No testing. Systemic or local |

**Conclusion**

The overall probability of entry of *Salmonella spp*. through imported semen to Iceland is estimated to be negligible.

The likelihood of infection is therefore considered as negligible. The consequences are therefore not considered.

## Bovine Respiratory Syncytial Virus

BRSV is present in the majority of the cattle herds in Norway and the agent has caused health problems in the herd at Øyer testing station. All calves are vaccinated against BRSV, although the effect of the vaccine is debated. Young potential semen bulls that leave Øyer have to be clinically healthy and respiratory disease has never been problem at the AIC (Store Ree). AIC has implemented efficient biosecurity measures so in practical sense the only transmission route into the facilities is by infected bulls. Latent infection may occur in young cattle but it is not proven that these animals transmit BRSV to susceptible cattle. We consider the probability that the AIC will become infected by BRSV to be low.

If the AIC becomes infected it is expected that at least some of the animals will show clinical symptoms. The probability that the infection will not be discovered is low.

There is no evidence for a viremic phase during a BRSV infection and the agent is fragile outside the cattle-body. Thus the virus will live short time in the environment and the possibility for transmission to semen is unlikely. A potential contamination of the semen by BRSV is considered to be very low to negligible.

BRSV infected semen will not be discovered during the export. There is no testing of the semen after leaving the AIC.

The BRSV replicates in the epithelial cells of the respiratory tract and is seldom found outside these organs. It is very unlikely that the virus will replicate in the uterus of a cow in oestrus.

If only some few cows in a herd are inseminated with contaminated semen and they become infected, there is only a moderate likelihood that the cows will show clinical symptoms. Systematic laboratory testing will not be carried out. Therefore, the probability of non-detection is considered to be moderate.

Table 7. Likelihood of each step necessary to import *Bovine respiratory syncytial virus* with frozen semen.

| SEMEN | Likelihood | Comments |
|---|---|---|
| Is the AIC infected? | Low | The bull calves become infected at the beginning of the stay at the testing station. They are vaccinated against respiratory diseases inclusive BRSV. Latent infection may occur in young cattle but it is not proven that these animals transmit BRSV to susceptible cattle. |
| Is the infection undetected? | Low | Introduction of BRSV into a susceptible herd will provoke clinical symptoms. |
| Is the semen from infected bulls contaminated? | Very low - Negligible | No evidence of viremia thus semen cannot be infected through the reproductive organs. The agent is fragile in the environment. Biosecurity measures during the semen collection |
| Is infected semen undetected during export? | High | No testing. |
| Does infected semen cause infection in the cow? | Very low | The virus will probably not replicate in the uterus of the cow. |
| Is infected cow undetected after insemination? | Moderate | Some adult cattle may not show clinical symptoms |

**Conclusion**

The overall probability of entry of BRSV through imported semen to Iceland is estimated to be negligible.

The likelihood of infection is therefore considered as negligible. The consequences are therefore not considered.

## Bovine corona virus

Bovine corona virus (BCoV) is widely distributed in Norway, but the agent has not been detected in Iceland. All calves at Øyer are vaccinated against respiratory BCoV, but the effect of the vaccine is uncertain. Potential semen bulls that leave Øyer have to be clinically healthy and respiratory disease has never been problem at the AIC (Store Ree). AIC has implemented strict biosecurity measures. Restricted introduction of new animals into the herd and strict biosecurity measures have shown to be very efficient to keep out onerous agents from the stall. We consider the probability that the AIC will become infected by BCoV to be low.

If the AIC becomes infected it is expected that at least some of the animals will show clinical symptoms. The probability that the infection will not be discovered is low.

A short viremia in the bull may lead to an infection of the semen, but we consider the likelihood to be very low. It is assumed that BcoV could survive in the environment for more than a week at room temperature, but faecal contamination can weaken the infectivity of the virus. A potential contamination of the semen by BCoV can nevertheless not be excluded.

BCoV infected semen will not be discovered during the export. There is no testing of the semen after leaving the AIC.

BCoV replicates only in the respiratory tract and in the intestine. It is very unlikely that a transmission could take place in the reproductive organs in the cow.

A subclinical respiratory infection will not be detected, but an infection in the intestine will tend to be clinical in a naïve population. The likelihood of no detection of a BCoV infection after introduction into a few cattle in Iceland is estimated to be moderate.

Table 8. Likelihood of each step necessary to import *Bovine corona virus* with frozen semen.

| SEMEN | Likelihood | Comments |
|---|---|---|
| Is the AIC infected? | Low | The bull calves may become infected at the beginning of the stay at the testing station (Øyer). They are vaccinated against respiratory diseases inclusive BCoV. Diseased animals will not be transferred to AIC. |
| Is the infection undetected? | Low | Subclinical / latent infection may occur |
| Is the semen from infected bulls contaminated? | Low | A low possibility of contamination of semen during viremia and from the environment. Biosecurity measures during the semen collection |
| Is infected semen undetected during export? | High | No testing. |
| Does infected semen cause infection in the cow? | Very low | The infection route through uterus will probably not lead to replication of the virus. |
| Is infected cow undetected after insemination? | Moderate | No quarantine. No testing. Subclinical infection may occur. |

**Conclusion**

The overall probability of entry of BCoV through imported semen to Iceland is estimated to be negligible.

The likelihood of infection is therefore considered as negligible. The consequences are therefore not considered.

## Bovine parainfluenza 3 virus

Bovine parainfluenza 3 virus is very common in the Norwegian cattle population, while in Island the agent has not been diagnosed. All calves at Øyer are vaccinated against BPiV-3, but the effect of the vaccine is uncertain. Often the BPiV-3 infection has a subclinical course and reoccurrence of the infection is possible

after some weeks. However, subclinical infections will produce less virus than clinical cases, therefore subclinical cases will probably not maintain the infection in a population. Only healthy bulls are transferred to quarantine station and further to the AIC. Restricted introduction of new animals into the herd and strict biosecurity measures will efficiently minimize the probability for introducing BPiV-3 into the AIC. We consider the probability that the AIC will become infected by BPiV-3 to be low.

If the AIC becomes infected it is expected that at least some of the animals will show minor clinical symptoms, but the symptoms may be missed. The probability that the infection will not be discovered is considered moderate.

There is no indication of semen being infected with BPiV-3 through the reproductive organs of the bulls. It is not known for how long the virus can survive in the environment, but in droplets the virus is stable for at least 3 hours and cold temperature (6 C°) enhance the viability. A contamination of the semen by BPiV-3 can not be excluded but is consideredvery unlikely.

BPiV-3 infected semen will not be discovered during the export. There is no testing of the semen after leaving the AIC.

Like the other respiratory viruses the replication site for BPiV-3 is the respiratory tract, the likelihood for transmission via uterus is therefore very low.

A subclinical respiratory infection which is probably the main route of BPiV-3 infection in adult cattle will not be detected. However, transmission to naïv calves in the same herd would most likely lead to clinical symptoms in at least some calves.

Table 9. Likelihood of each step necessary to import *Bovine parainfluenza 3 virus* with frozen semen.

| SEMEN | Likelihood | Comments |
|---|---|---|
| Is the AIC infected? | Low | The bull calves become infected at the beginning of the stay at the testing station. They are vaccinated against respiratory diseases inclusive BPiV3 |
| Is the infection undetected? | Moderate | BPiV3 as single infection will probably not be detected, but the agent occurs mostly together with other respiratory agents (BRSV and/or BCoV). Subclinical infections may happen. |
| Is the semen from infected bulls contaminated? | Very low | A very low possibility of contamination of semen from the environment. Biosecurity measures during the semen collection |
| Is infected semen undetected during export? | High | No testing. |
| Does infected semen cause infection in the cow? | Very low | It is very unlikely that the virus will be absorbed or replicate in the uterus of the cow. |
| Is infected cow undetected after insemination? | High | No quarantine. No testing. Infections in adult cattle will most probably be subclinical, while exposed calves in the same herd will easier be diseased and show clinical symptoms. |

**Conclusion**

The overall probability of entry of *bovine parainfluenza 3 virus* through imported semen to Iceland is estimated to be negligible.

T The likelihood of infection is therefore considered as negligible. The consequences are therefore not considered.

### *Neospora caninum*

A study in Norway has shown a very low sero-prevalence of NC at the herd level. Thus the likelihood of transmission to the AIC is considered to be very low.

An infection with NC in the breeding bull population will be very difficult to discover because the bulls show no symptoms and there is no testing for the infection.

The semen from infected bulls will contain tachyzoites of NC.

The infected semen will not be detected during export because there is no testing of the semen during the export.

There is no evidence that semen infected with tachyzoites has led to a natural infection in cows. The density of tachyzoites in the semen is probably too low to create an infection. But in trials with much higher tachyzoite-load than obtained with normal insemination, no abortion but an antibody response in the recipient has been detected.

The infection in the inseminated cows will probably not be detected since only a small proportion of the infected cows will abort during the pregnancy.

Table 10. Likelihood of each step necessary to import *Neospora caninum* with frozen semen.

| SEMEN | Likelihood | Comments |
|---|---|---|
| Is the AIC infected? | Very low | Very low seroprevalence in the cattle population in Norway |
| Is the infection undetected? | High | No clinical symptoms. No testing. |
| Is the semen from infected bulls contaminated? | High | Infected bulls will shed the parasite in the semen. Potential Leukocytes in semen will also contain tachyzoites. |
| Is infected semen undetected during export? | High | No testing. |
| Does infected semen cause infection in the cow? | Very low | Trials with parasite density far beyond the natural occurring parasite content in semen have not resulted in a clear cause of abortion, just immunological response. |
| Is infected cow undetected after insemination? | High | Abortion happens only in a little proportion of the infected cows |

**Conclusion**

The overall probability of entry of *Neospora caninum* through imported semen to Iceland is estimated to be very low. The probability of entry and infection of icelandic cattle is considered to be negligible.

The likelihood of infection is therefore considered as negligible. The consequences are therefore not considered.

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# Annexes

## Annex 1.

**OIE guidelines for bovine semen**

http://www.oie.int/fileadmin/Home/eng/Health_standards/tahc/2010/en_chapitre_1.1.6.htm

## Annex 2. (In Norwegian)

Forskrift om dyrehelsemessige vilkår for produksjon, lagring, import og eksport av oksesæd

http://lovdata.no/dokument/SF/forskrift/2003-10-06-1242

## Annex 3.

**COUNCIL DIRECTIVE 2003/43/EC**

of 26 May 2003

amending Directive 88/407/EEC laying down the animal health requirements applicable to intra-Community trade in and imports of semen of domestic animals of the bovine species

http://eurlex.europa.eu/search.html?instInvStatus=ALL&or0=DTS%3D3,DTS%3D0&or1=DTT%3DL&DTN=0043&DTA=2003&qid=1395665649314&DTC=false&DTS_DOM=ALL&type=advanced&SUBDOM_INIT=ALL_ALL&DTS_

## Annex 4

**KOORIMP**

**Additional requirements: For bovine semen**
**In force from 22.03.2013**

**By the importation of cattle semen from a number of European countries KOORIMP and GENO demand that the donor bull has been tested for Schmallenberg virus.**

**Overall additional requirements:**

- Semen is produced in a well established station and is mediated by an exporter who has good reputation and experience in export.
- The sperm is frozen.
- Semen from the United Kingdom must have been taken out after the year 2000.

**For IBR/IPV one of the following three additional requirements must be met:**

- Semen is produced in a country which is officially free from IBR/IPV and the donor has stayed in the export country all it's life.
- If the exporting country has IBR/IPV, the donor should be documented serologically negative for and not vaccinated against IBR/IPV minimum 21 days after the semen collection.
- After the reception in Norway the individual semen collection shall be examined for the IBR virus with PCR technique with negative result before the sperm is used.

**For BVD one of the following two additional requirements must be met:**

- The donor is tested for BVD-virus with negative result, and tested for antibodies against BVD-virus with negative results a minimum of 21 days after the semen collection
- Semen from the current ejaculate has been tested for BVD-virus with PCR technique, with negative results.

**For Schmallenbergvirus one of the following three additional requirements must be met:**

- The donor is tested for antibody against SBV (serum ELISA) with negative results at least 21 days after the semen collection.
- The donor is tested for antibody against SBV (serum ELISA) and with the RT-PCR for SBV with negative results not more than 14 days after the semen collection.

**For bluetongue there are no requirements for the testing of semen that is produced in countries with freedom of bluetongue for at least 6 months before the date of production. If this is not the case, one of the following additional requirements must be met:**

- The Donor must have tested negative for antibodies against the Bluetongue virus (BTV) no earlier than 21 days after the semen collection.*
- The Donor must have tested negative for the Bluetongue virus (BTV) no later than 28 days after the semen collection.**

* In the case of semen that is imported from Germany, Netherlands, Belgium, Luxembourg or France will the requirements apply to semen which is collected after 1.of May 2006. In the case of semen from the UK, Austria, Switzerland, Poland and the Czech Republic the requirements apply for the semen collected after 1.of September 2007. For Sweden, Denmark and Finland the requirements apply for semen collected after 1.of September 2007 and before the 1.of March 2011.

** The requirement applies to semen that are collected and produced in the United Kingdom, Germany, Switzerland, Austria, France, Netherlands, Belgium, Italy, Spain, Finland, Denmark and Sweden.

ADDITIONAL REQUIREMENTS
REGARDING IMPORT OF BOVINE
SEMEN DEMANDED BY
GENO, Breeding and A.I. Association,
Norway

**Country of collection:**...Sweden/ Denmark / Finland…(delete as necessary).

**Approval no. of semen collection centre:**.....

**Identification of semen**

| Number of doses | Date of collection | Identification of donor bull | Breed | Date of birth |
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**General requirements:**
**The semen must be frozen.**

**1. Regarding Para tuberculosis (Johne`s disease)**
At least one of the following tests must have been carried out (delete as necessary):

a. Serological test (ELISA or complement fixation) done on the donor bull on the

…...../..... not earlier than 21 days after semen collection, has given negative result.
Or

b. One straw of the ejaculate(s) in question is/are tested by PCR-technique with negative result(s).

**2. Regarding Infectious Bovine Rhino-tracheitis/Infectious pustular Vulvo-vaginitis, IBR/IPV** In addition to demands concerning IBR/IPV in Council Dir. 88/407/EEC, Annex B, one of the following alternatives has been carried out (delete as necessary):

a. The semen is produced in a country officially free from IBR/IPV and the donor bull(s) has been in this country from birth.
Or

Veterinærinstituttet er et nasjonalt forskningsinstitutt innen dyrehelse, fiskehelse, mattrygghet og dyrevelferd med uavhengig forvaltningsstøtte til departementer og myndigheter som primæroppgave. Beredskap, diagnostikk, overvåking, referansefunksjoner, rådgivning og risikovurderinger er de viktigste virksomhetsområdene.

Veterinærinstituttet har hovedlaboratorium i Oslo og regionale laboratorier i Sandnes, Bergen, Trondheim, Harstad og Tromsø, med til sammen ca. 330 ansatte.

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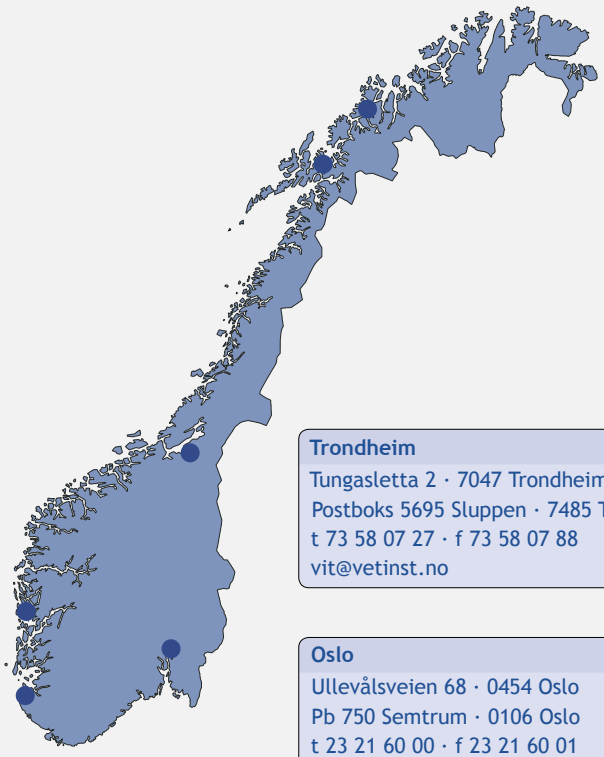


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