

AUSTRALIAN VETERINARY EMERGENCY PLAN

# **AUSVETPLAN**

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**Response strategy**

## **Foot-and-mouth disease**

**Version 5.5**

AUSVETPLAN is a series of response plans that describe the proposed Australian approach to an emergency animal disease incident. The documents provide guidance based on sound analysis, linking policy, strategies, implementation, coordination and emergency management plans.

**National Biosecurity Committee**

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# 1 Introduction

## 1.1 This manual

### 1.1.1 Purpose

As part of AUSVETPLAN (the Australian Veterinary Emergency Plan), this response strategy contains the nationally agreed approach for the response to an incident — or suspected incident — of foot-and-mouth disease (FMD) in Australia. It has been developed to guide decision making to ensure that a fast, efficient and effective response can be implemented consistently across Australia with minimal delay.

### 1.1.2 Scope

This response strategy provides information about:

- the disease (Section 2)
- the implications for Australia, including potential pathways of introduction; social, environmental, human health and economic effects; and the critical factors for a response to the disease (Section 3)
- the agreed policy and guidelines for agencies and organisations involved in a response to an outbreak (Section 4)
- declared areas and premises classifications (Section 5)
- biosecurity controls, including quarantine and movement controls (Section 6)
- response surveillance and establishing proof of freedom (Section 7).

The key features of FMD are described in the **Foot-and-mouth disease fact sheet** (Appendix 1).

### 1.1.3 Development

The strategies in this document for the diagnosis and management of an outbreak of FMD are based on risk assessment. They are informed by the recommendations in the World Organisation for Animal Health (WOAH) *Terrestrial animal health code* (Chapter 8.8) and the WOAH *Manual of diagnostic tests and vaccines for terrestrial animals* (Chapter 3.1.8). The strategies and policy guidelines are for emergency situations and are not applicable to policies for imported animals or animal products.

## 1.2 Other documentation

This response strategy should be read and implemented in conjunction with:

- other AUSVETPLAN documents, including the operational, enterprise and management manuals; and any relevant guidance and resource documents. The complete series of manuals is available on the Animal Health Australia website<sup>1</sup>
- relevant nationally agreed standard operating procedures (NASOPs). These procedures complement AUSVETPLAN and describe in detail specific actions undertaken during a response to an incident.

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<sup>1</sup> <https://animalhealthaustralia.com.au/ausvetplan>

NASOPs have been developed for use by jurisdictions during responses to emergency animal disease (EAD) incidents and emergencies

- relevant jurisdictional or industry policies, response plans, standard operating procedures and work instructions
- relevant Commonwealth and jurisdictional legislation and legal agreements (such as the Emergency Animal Disease Response Agreement — EADRA<sup>2</sup>), where applicable.

## 1.3 Training resources

### EAD preparedness and response arrangements in Australia

The EAD Foundation online course<sup>3</sup> provides livestock producers, veterinarians, veterinary students, government personnel and emergency workers with foundation knowledge for further training in EAD preparedness and response in Australia.

#### 1.3.1 Disease-specific training

Training specific to FMD includes:

- Biosecurity Queensland online training program for veterinarians and veterinary paraprofessionals<sup>4</sup>
- training material and resources from the European Commission for the Control of Foot-and-Mouth Disease.<sup>5</sup>

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<sup>2</sup> <https://animalhealthaustralia.com.au/eadra>

<sup>3</sup> <https://animalhealthaustralia.com.au/online-training-courses/>

<sup>4</sup> [www.business.qld.gov.au/industries/service-industries-professionals/service-industries/veterinary-surgeons/foot-mouth-info/fmd-training-vets](http://www.business.qld.gov.au/industries/service-industries-professionals/service-industries/veterinary-surgeons/foot-mouth-info/fmd-training-vets)

<sup>5</sup> <https://eufmdlearning.works/>

## 2 Nature of the disease

### 2.1 Aetiology

Foot-and-mouth disease (FMD) virus is a member of the *Aphthovirus* genus in the *Picornaviridae* family of RNA viruses. There are seven immunologically and serologically distinct serotypes of FMD virus: types O, A, C, SAT 1, SAT 2, SAT 3 and Asia 1. Serotype C has not been reported since an outbreak in 2005 in Ethiopia and may no longer exist outside laboratories (Jamal & Belsham 2013, FAO 2017).

Within each serotype, there is a wide spectrum of antigenic diversity. Strains within each serotype may differ in their infectivity for different species. Virus strain also affects immunity (see Sections 2.6 and 2.7).

FMD virus is prone to mutation through replication and recombination (OIE 2013).

In Australia, FMD is a security sensitive biological agent (SSBA) and is covered by the SSBA Regulatory Scheme,<sup>6</sup> which limits the opportunities for acts of bioterrorism to occur using FMD virus and other harmful biological agents.

### 2.2 Susceptible species

Domestic and wild cloven-hoofed animals (order *Artiodactyla*) are the natural hosts of FMD virus. A few species in other orders are also susceptible. The main production species of significance are cattle, pigs, sheep, goats, deer (red, fallow and roe) and water buffalo (*Bubalus bubalis*). According to the World Organisation for Animal Health (WOAH) *Terrestrial animal health code*, Bactrian camels (*Camelus bactrianus*) are sufficiently susceptible to be of epidemiological significance. Observations on natural and experimental FMD have failed to show convincingly that dromedary camels have the same susceptibility to FMD virus as ruminants or pigs (Alexandersen et al 2008, Larska et al 2009). South American camelids (alpacas, llamas, vicuña and guanacos) are susceptible to infection but are not considered to be of epidemiological significance. Australian feral camels are dromedaries (*Camelus dromedarius*).

Horses are not susceptible.

Other susceptible wild and zoo animals include bison, African buffalo (*Syncerus caffer*), antelopes, gazelles, moose, impala, giraffe, wildebeest, eland, elephants and warthog. FMD has been reported in various species that exist in the wild in other countries — including European hedgehogs, chinchillas, muskrats, armadillos, peccaries, tapirs (Ramsay & Zainuddin 1993, Hernandez-Divers et al 2007) and Asiatic black bears (Officer et al 2014). These species are not generally implicated in the spread of FMD. Rhinoceroses are not susceptible.

Several Australian marsupial species (red kangaroo, grey kangaroo, tree kangaroo, wombat, brushtail possum, long-nosed bandicoot, potoroo, water rat, brown antechinus, Bennett's wallaby), as well as echidnas and feral European rabbits, have been tested overseas for susceptibility to FMD (Snowdon 1968). These species showed minimal disease or spread of infection between animals following experimental inoculation with FMD virus. The author of the study concluded that the Australian fauna tested would contribute to spread of FMD in the field only under exceptional conditions. Close contact would be required between livestock and fauna for spread of infection — for example, at watering holes during droughts. The contribution of marsupial species to an FMD outbreak would require assessment on a case-by-case basis,

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<sup>6</sup> [www.health.gov.au/ssba](http://www.health.gov.au/ssba)

similar to other wild and feral animal species. Further information on kangaroo management is in the **AUSVETPLAN Operational manual: *Wild animal response strategy***.

FMD virus may be transmitted to mice, rats, guinea pigs, hamsters and chickens by inoculation, but these animals are not thought to be important in transmitting FMD virus in the field (Arkwright & Burbury 1925).

### **2.2.1 Zoonotic potential**

FMD is considered a rare human disease and is not a public health concern (Armstrong et al 1967). The infection is temporary and mild, only very occasionally resulting in clinical disease (fever, vesicles on the hands or feet or in the mouth). FMD is not a food safety concern. It cannot be transmitted to humans through consuming commercially produced meat, milk or dairy products, which would continue to be safe to consume in an FMD outbreak.<sup>7</sup> It is not the same as hand, foot and mouth disease of humans (see Section 4.2).

## **2.3 World distribution**

For the latest information on the distribution of FMD, refer to the WOAHP World Animal Health Information System database.<sup>8</sup>

### **2.3.1 Distribution outside Australia**

FMD is endemic in many parts of Africa, the Middle East and Asia, and parts of South America. Different FMD virus strains circulate in different parts of the world and can be tracked using viral genome sequencing.

WOAH maintains a list of countries and zones that it recognises to be officially FMD-free (with and without vaccination).<sup>9</sup>

The WOAHP World Animal Health Information System database provides information on the FMD situation of member countries.<sup>10</sup>

### **2.3.2 Occurrence in Australia**

Australia is recognised by WOAHP as a country free from FMD without vaccination.

Minor outbreaks of possible FMD in Australia were reported in 1801, 1804, 1871 and 1872. The last incident occurred in Victoria following importation of a bull from England. Two farms were involved before the disease was eradicated by stamping out (Bunn et al 1998).

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<sup>7</sup> [www.foodstandards.gov.au/consumer/safety/Pages/Animal-diseases,-human-health-and-food-safety.aspx#:~:text=FMD%20is%20not%20a%20food%20safety%20concern.%20It,foot%20and%20mouth%20disease%20which%20commonly%20affects%20children](http://www.foodstandards.gov.au/consumer/safety/Pages/Animal-diseases,-human-health-and-food-safety.aspx#:~:text=FMD%20is%20not%20a%20food%20safety%20concern.%20It,foot%20and%20mouth%20disease%20which%20commonly%20affects%20children)

<sup>8</sup> <https://wahis.woah.org/#/home>

<sup>9</sup> [www.woah.org/en/disease/foot-and-mouth-disease/#ui-id-2](http://www.woah.org/en/disease/foot-and-mouth-disease/#ui-id-2)

<sup>10</sup> <https://wahis.woah.org/#/home>

## 2.4 Epidemiology

### 2.4.1 Incubation period

When spread is occurring within a herd or flock, the typical incubation period for FMD is 2–6 days but may range from less than 24 hours up to 14 days (Kitching 2002, Kitching & Alexandersen 2002, Kitching & Hughes 2002). For between-farm spread, it is more likely to be 2–14 days (DEFRA 2006).

Section 2.5.1 provides information on lesion ageing to aid determination of the time of introduction of the virus.

#### WOAH incubation period

For the purposes of the WOAH *Terrestrial animal health code*, the incubation period<sup>11</sup> for FMD is 14 days.

### 2.4.2 Persistence of agent and modes of transmission

#### General properties

FMD virus is small, with no lipid in the envelope.

FMD virus is most stable at pH 7.2–7.6 but will remain viable at pH 6.7–9.5 if the temperature is 4 °C or lower. Although inactivation times depend on many factors, the FMD virus half-life (or, under optimal conditions, the 10-fold reduction time) is approximately 12 hours at pH 6.5, 1 minute at pH 6, and 1 second at pH 5 (Alexandersen 2005).

Raising the temperature reduces the time for which FMD virus remains viable. At temperatures below freezing point, FMD virus is stable almost indefinitely. Although there is some variation between strains in resistance to temperature and/or pH stress, exposure to 56 °C for 30 minutes is sufficient to destroy most strains (Maree et al 2013).

Sunlight has little or no direct effect on infectivity of FMD virus; any loss of viability is due to secondary drying and temperature (Donaldson 1972).

The viability of airborne FMD virus is mainly influenced by relative humidity, with good viability above 60% relative humidity and rapid inactivation below 60% (Donaldson 1972).

FMD virus is susceptible to a range of disinfectants, including sodium hydroxide (2%), sodium carbonate (4%), citric acid (0.2–3%<sup>12</sup>), acetic acid (2%), sodium hypochlorite (3%), potassium peroxymonosulfate/sodium chloride (1%) and chlorine dioxide (OIE 2013). For porous surfaces (e.g. wooden floors), higher concentrations of citric acid (at least 2%) are recommended (Krug et al 2012). Refer to the Australian Pesticides and Veterinary Medicines Authority for the latest information on relevant minor use permits for products used as disinfectants to treat equipment, fabric and surfaces in the event of an outbreak of FMD.<sup>13</sup>

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<sup>11</sup> In the WOAH Terrestrial Code, 'incubation period' means the longest period that elapses between the introduction of the pathogenic agent into the animal and the occurrence of the first clinical signs of the disease. See [www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=glossaire.htm](http://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=glossaire.htm).

<sup>12</sup> <https://permits.apvma.gov.au/PER92652.PDF>

<sup>13</sup> <https://portal.apvma.gov.au/permits>

FMD virus is resistant to iodophores, quaternary ammonium compounds and phenol (OIE 2013).

The **AUSVETPLAN Operational manual: *Decontamination*** provides additional guidance on the use of disinfectants against FMD virus.

## **Environment (including windborne spread)**

FMD virus can remain infective in the environment for several weeks and possibly longer in the presence of organic matter, such as soil, manure and dried animal secretions, or on chemically inert materials, such as straw, hair and leather. It was reported to persist for 345 days on one farm in California in 1924 (Morgan 1993). FMD virus is reported as remaining viable for up to 50 days in water (Mahnel et al 1977).

Windborne spread<sup>14</sup> is a complex phenomenon and is affected<sup>14</sup> by a range of factors, including the strain of FMD virus, virus concentration, atmospheric conditions, local topography and terrain, and the density and susceptibility of animals in the exposed downwind area. In the 2001 outbreak of FMD in the United Kingdom (UK), the average spatial distance between transmission-linked cases indicated that FMD virus could infect susceptible animals approximately 9 km from the source (Salje et al 2016). As well, airborne spread of FMD virus occurred between Brittany and the Isle of Wight (Donaldson et al 1982). Under suitable conditions, windborne spread could lead to transmission of FMD virus over several kilometres in Australia (Garner & Cannon 1995), but it is unlikely that this distance would be as great as in the 2001 UK outbreak. Cool and wet weather conditions favour FMD virus transmission. Use of the SPREAD application during Australian FMD outbreaks may be useful in determining the significance of windborne spread as part of short-term (1–4 days) weather forecasts.

## **Local spread**

In the 2001 UK FMD outbreak, local spread was attributed as the cause of new infected premises (IPs) if the new IP was within 3 km of a previously confirmed IP and more than one possible transmission pathway was identified (Gibbens et al 2001). In the first 5 months of the outbreak, 79% of spread was attributed to local spread to 1849 IPs across 12 geographic areas (Gibbens et al 2001). Gibbens et al (2001) suggested that contiguous grazing areas on neighbouring holdings occupied by livestock are an important factor in local spread, and that fomite and [short distance] aerosol transmission appear to be the predominant method of transmission within a cluster of IPs.

In the Japanese FMD outbreak of 2010, pig farms were more likely to induce local spread<sup>15</sup> than cattle farms, and the likelihood of local spread increased as the farm size increased (Hayama et al 2012). Similarly, pig source farms resulted in infection of more neighbouring farms in a short time than cattle source farms. Hayama et al (2012) also noted that large pig farms posed a greater risk of inducing local spread, and that medium-sized and large cattle farms had a greater risk of induced infection. They noted that 70% of neighbouring farms within 500 m of infected pig farms developed clinical signs within 14 days of clinical signs on the pig source farm.

The observations of Hayama et al (2012) are consistent with knowledge that pigs amplify FMD virus and cattle are highly susceptible to infection. However, there are gaps in knowledge or assumptions, and the exact mechanisms of local spread have not been fully determined. Gibbens et al (2001) indicated that most local spread is believed to result from local aerosol spread between animals, particularly where they are

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<sup>14</sup> 'Windborne spread' refers to infection of animals some distance from known foci and without any history of contact with infected animals, through movement of virus on the wind (Donaldson 1983). It is distinct from the short-distance aerosol transmission that commonly occurs between animals. It is also different from 'local spread'.

<sup>15</sup> In the 2010 Japanese outbreak, 'local spread' was defined as disease transmission from a source farm to neighbouring farms within a radius of 500 m around the source farm (Hayama et al 2012).

contiguous, or by contamination in the area near an IP, resulting in infectious material on roads or other common facilities. Accordingly, the greater susceptibility of large cattle farms noted by Hayama et al (2012) may be associated with the inherent susceptibility of cattle, as well as the large management scale and frequent movements of animals, people, equipment and vehicles on and off farm.

Hayama et al (2012) concluded that causes of local spread were complex and depend on a range of factors, including location and layout of the farm; farm biosecurity practices; and the frequency of movement of animals, people, equipment and vehicles within a short distance. In addition, they noted that patterns of local spread would vary with background characteristics, such as geographical or topographical features, animal density, production type and volume of virus around the area.

Notwithstanding the above, understanding the potential risk of local spread in an affected area is critical for decision makers when formulating preventive or control measures. Culling infected piggeries, as virus amplifiers, is likely to reduce the amount of local spread, particularly where cattle are within the local area. In areas where medium-sized or large cattle farms are present, emergency vaccination may be more appropriate than pre-emptive culling, considering the high disease sensitivity of cattle and the time required for culling operations.

## **Live animals**

FMD is one of the most contagious animal diseases.

Movement of infected animals is widely recognised as one of the most important routes by which FMD spreads between herds and farms. Transmission occurs most readily when animals are in close proximity, such as at watering and feeding points, and congregation points such as stockyards and milking sheds.

Animals are infected via inhalation, ingestion and artificial or natural breeding. The primary route of infection in ruminants is inhalation of contaminated aerosols. In contrast, pigs are mainly infected through ingesting contaminated feed.

Infected animals excrete virus in ruptured vesicular fluid, exhaled air, saliva, milk, semen, faeces and urine. Both clinically affected animals and preclinical animals can shed large quantities of virus. For example, excretion in semen and milk can occur for up to 4 days before clinical signs appear, and sheep excrete virus in their breath for around 24 hours before signs are apparent (Donaldson 1983). Virus excretion from most sites diminishes rapidly with the appearance of circulating antibodies. Most excretion of virus ceases within 6 days of the appearance of vesicles, although FMD virus has been detected in milk up to 3 weeks after the appearance of clinical signs (Alexandersen 2005), and in the semen of experimentally infected cattle for up to 8 weeks (Meyer et al 2017).

There are host species differences in both the excretion of virus and susceptibility via different routes of infection; these are discussed in Section 2.4.3.

## Carriers

The carrier state<sup>16</sup> of FMD virus is a common sequela for infected ruminants, particularly cattle and African buffalo (*Syncaerus caffer*). The duration of the carrier state depends on the individual animal, the animal species and the virus strain. FMD virus may be recovered in probang samples intermittently, but not in excretions such as saliva and semen during the carrier state (Alexandersen et al 2002). FMD virus excretion by carrier animals is intermittent (Abd El Wahed et al 2013).

Ruminants vaccinated against FMD may also become carriers if exposed to infection, especially in the first few days after vaccination.

Neither pigs nor camelids become carriers of FMD virus (Alexandersen et al 2002).

The risk of disease transmission from carrier animals is controversial. Stenfeldt & Arzt (2020) stated that 'neither re-activation of clinical disease nor vertical transmission has ever been documented from FMD virus carrier cattle'. They concluded from a range of studies that FMD virus transmission from persistently infected cattle is unlikely; however, transmission from persistently infected African buffalo may be more common. There is evidence that carrier buffalo have a role in the epidemiology of FMD in southern Africa (Condy et al 1985).

Importantly, virus carriers represent a natural reservoir of FMD virus in infected areas and a potential source of antigenically altered virus variants, since variants of the virus continually emerge and are selected in the animal during the carrier state (Wittman et al 1990).

## Live wild (including feral) animals

Transmission of FMD virus could occur between wild (including feral) animals and domestic herds, which could result in spread of FMD.

The role of feral pigs in an outbreak of FMD in Australia is unknown. The Australian Government Department of Agriculture, Fisheries and Forestry and the University of Sydney modelled FMD outbreaks in northwestern Australia (Ward et al 2015). Domestic cattle and feral pig populations were represented as epidemiologically relevant groups. The findings suggested that, if FMD is controlled in domestic livestock, it is likely to be self-limiting in feral pigs. However, to eradicate disease as quickly as possible, feral animal populations within known disease areas may be targeted for surveillance and, if necessary, disease control, depending on the specific circumstances of the outbreak.

Observations on natural and experimental FMD have failed to show convincingly that dromedary camels have the same susceptibility to FMD virus as ruminants or pigs (Alexandersen et al 2008, Larska et al 2009).

Feral goats may play a role in the epidemiology of FMD because of their potential to be virus carriers and vague clinical signs (Fleming 2004).

Six species of deer — chital, red, rusa, fallow, hog and sambar — are present in Australia. As a result of their isolation into small groups and general separation from livestock, it is considered that infection of cattle from deer is unlikely. However, more knowledge is required about the likelihood of contact between wild deer and commercial properties in high-risk areas (Bunn 2013). During an Australian FMD outbreak, the role of deer in the epidemiology of the outbreak may be considered for investigation.

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<sup>16</sup> Carriers are defined as ruminants in which virus can be intermittently found in the oropharyngeal area more than 28 days after infection, often without the animals displaying clinical disease. The FMD virus carrier state is referred to in some literature as persistent infection. For the purposes of this manual, these terms are considered synonymous.

Similarly, the role of water buffalo in the epidemiology of an Australian FMD outbreak would require investigation at the time of the outbreak. Their role as FMD virus carriers means that they may be involved in maintenance and transmission of virus, particularly in areas where they are abundant (e.g. the top end of the Northern Territory).

Refer to Appendix 5 for further information on the behaviour of FMD virus in live wild (including feral) animals overseas.

## **Carcasses**

Infected carcasses (as well as fetal membranes) pose a transmission risk of FMD virus to susceptible animals (including feral animals), whether by direct ingestion or ingestion of contaminated forage, roots and soil.

## **Animal products**

### **Meat, meat products and casings, including use as animal feed**

FMD virus is inactivated rapidly once the pH falls below 6.2 (Cottral 1960), which occurs within 3 days in the meat of carcasses that have undergone normal post-slaughter acidification. However, the virus may remain viable for prolonged periods in meat if the pH does not fall below 6.2. This might happen when carcasses are chilled rapidly (Paton et al 2009). Dark, firm, dry (DFD) pig meat may also fail to undergo post-slaughter acidification that would inactivate FMD virus. As well, virus can remain viable for months in chilled or frozen lymph nodes, bone marrow, viscera and residual blood clots. Deboning and removal of lymph nodes has been an accepted processing strategy for many years.

FMD virus may remain viable for prolonged periods in salted and cured uncooked meats (Dhennin et al 1980ab); it has been recovered from sausages for up to 56 days, ham fat for up to 183 days and bacon for up to 190 days.

Dry cured meat products have been investigated for viability of FMD virus. Iberian hams, Iberian shoulder hams, Iberian loins and white Serrano hams were found to be free of viable FMD virus by day 168, 112, 42 and 182, respectively, post-slaughter (Mebus et al 1993).

FMD virus has been recovered from processed intestinal casings from experimentally infected sheep, stored for 14 days at 4 °C (Bohm & Krebs 1974, Bohm 1975), and from processed pig intestinal casings for up to 250 days (Blackwell 1976).

Various procedures are reported to reduce the risk of FMD virus spread associated with processed items such as sausage casings derived from ruminant and pig intestines (Wijnker et al 2007, 2011).

The WOAHA Terrestrial Code chapter for FMD<sup>17</sup> details recommended procedures for inactivating FMD virus in meat, meat products and casings through canning, cooking, and drying after salting.

### **Milk and dairy products, including use as animal feed**

Unpasteurised raw milk and milk products from infected FMD-susceptible animals can contain considerable quantities of FMD virus (Salwa & Gaber 2007). FMD virus may be shed in milk from infected animals up to

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<sup>17</sup> [www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access](http://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access)

4 days before the onset of clinical signs and for up to 3 weeks afterwards (Alexandersen 2005). FMD virus has been detected in the milk of experimentally infected cattle for 23 days (Reid et al 2005).

The viability of FMD virus in raw milk and milk products was reviewed by Morgan (1993), who highlighted the following:

- In cow's milk and butter preserved under cold conditions, FMD virus can remain viable for 14–45 days (Blackwell & Hyde 1976).
- In dried skim milk produced from raw milk, FMD virus can remain viable for up to 2 years (Cottral 1969).

FMD virus has not remained viable in cheddar cheese cured for longer than 30 days (Blackwell 1976).

Although FMD virus can remain viable following pasteurisation, there are no reports to date of processed milk, or feeding or transport of processed milk or dairy products, causing disease spread during an outbreak.

The WOAH Terrestrial Code chapter for FMD details recommended procedures for inactivating FMD virus in milk.

### *Food safety*

FMD is not a food safety concern. It cannot be transmitted to humans through consuming commercially produced meat, milk or dairy products, which would continue to be safe to consume in an FMD outbreak.<sup>18</sup> Milk, milk products or milk byproducts either of Australian provenance or legally imported for stockfeed use into Australia can be legally fed to pigs as an exemption under the nationally agreed prohibited pig feed definition (see 'Prohibited pig feed' in glossary); however, feeding of these products will be prohibited during an FMD outbreak.

## **Animal byproducts**

### **Hides, skin, wool and other fibres**

The persistence of FMD virus on untreated wool and other fibres, skins and hides means that the virus could be transmitted to susceptible animals coming into contact with these products.

The WOAH Terrestrial Code chapter for FMD details recommended procedures for inactivating FMD virus in wool, hides, bristles, skins and trophies. These procedures include, but are not limited to the following time x temperature storage parameters based on McColl et al 1995:

- 4 months at 4 °C storage
- 4 weeks at 18 °C storage
- 8 days at 37 °C storage.

### *Skins*

Persistence of FMD virus in skin tissue is determined by the rate of degradation of virus as a result of acidification. Salting or refrigeration of skins retards degradation and allows the virus to persist. Fully processed skins are a negligible disease risk for FMD (Scott Williams Consulting & Herd Health 2017).

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<sup>18</sup> [www.foodstandards.gov.au/consumer/safety/Pages/Animal-diseases,-human-health-and-food-safety.aspx#:~:text=FMD%20is%20not%20a%20food%20safety%20concern.%20It,foot%20and%20mouth%20disease%20which%20commonly%20affects%20children](http://www.foodstandards.gov.au/consumer/safety/Pages/Animal-diseases,-human-health-and-food-safety.aspx#:~:text=FMD%20is%20not%20a%20food%20safety%20concern.%20It,foot%20and%20mouth%20disease%20which%20commonly%20affects%20children)

### *Hides*

FMD virus has been recovered from green salted hides for up to (Gailiunas & Cottral 1967):

- 90 days at 15 °C
- 352 days at 4 °C.

Hides cured for 20 hours in saturated brine with up to 500 ppm of available chlorine still had detectable FMD virus after 4 weeks of storage at 15 °C. FMD virus was also detected in a hide sample dried for 42 days at 20 °C and 40% relative humidity (Gailiunas & Cottral 1967).

Hides cured in salt for 7 days and then dried at 20 °C were found to be infectious for FMD virus for 21 days (Gailiunas & Cottral 1967).

### *Wool and other fibres*

FMD virus has been recovered from wool from infected sheep following natural exposure (McColl et al 1995). FMD virus could be recovered from greasy wool for up to 14 days after experimental contamination.

Factors influencing viability of FMD virus on wool and fibre include the presence of organic material (e.g. faeces), temperature and relative humidity in storage.

### **Prohibited pig feed and meat meal**

Many FMD outbreaks overseas have originated from feeding to pigs of prohibited pig feed (also referred to as swill), containing contaminated animal products, or meat scraps and bones from infected animals. Feeding of, or allowing pigs access to, prohibited pig feed is illegal in all Australian states and territories.

The nationally agreed definition of prohibited pig feed lists 100 °C for 30 minutes as an approved process for treatment of prohibited pig feed. This exceeds the recommendations in the WOAHA Terrestrial Code chapter for FMD for inactivating FMD virus in meat and meat products.

### **Semen and embryos from live susceptible animals**

FMD virus has been found in bull semen 4 days before, during and up to at least 37 days after the appearance of clinical signs. It has also been found in bovine semen stored at –50 °C for 320 days (Cottral et al 1968).

FMD virus has also been found in pig semen, and is likely to occur in sheep and goat semen. The virus enters semen as a result of viraemia or lesions around the preputial orifice.

McVicar et al (1978) isolated FMD virus in boar semen up to 9 days post-exposure, and van Rijn et al (2004) noted that excretion in boars could be intermittent. Clinically normal boars can shed FMD virus in their semen (Maes et al 2008). Nonspecific antiviral and cytotoxic substances can complicate virus detection (Morgan 1993).

Van Rijn et al (2004) concluded that artificial insemination (AI) is a potential transmission mechanism for FMD infection, although the presence of a pathogen in semen used for AI is not proof that it caused infection in the sow herd. The risk of FMD transmission through AI must be ascertained based on likelihood and consequence. Following WOAHA protocols identified in Chapters 8.8, 4.6 and 4.7 of the WOAHA Terrestrial Code will reduce the likelihood of FMD transmission through AI.

For cattle embryos derived either in vivo or in vitro, FMD has been listed as a Category 1 disease by the International Embryo Technology Society (i.e.TS). Category 1 diseases or pathogenic agents are those for

which there is sufficient evidence to show that the risk of transmission is negligible, provided that the embryos are properly handled between collection and transfer, according to IETS guidelines.<sup>19</sup> However, the likelihood of transmission of FMD virus via unwashed embryos (both in vivo and in vitro) is high.

For sheep, goat and pig embryos derived in vivo, FMD has been listed as a Category 3 disease by the IETS. Category 3 diseases or pathogenic agents are those for which preliminary evidence indicates that the risk of transmission is negligible, provided that the embryos are properly handled between collection and transfer, according to the IETS manual, but for which additional in vitro and in vivo experimental data are required to substantiate the preliminary findings.

## **Specimens**

Handling of specimens for laboratory investigation poses a rare risk of FMD virus transmission to people. However, specimens in transport and in the laboratory environment require risk mitigation practices to minimise the potential for accidental virus spread or escape from packaging, specimen receptacles and laboratory environments.

## **Waste products and effluent**

Effluent from IPs (particularly piggeries and dairies) that drains onto roads, stock routes or pastures, or into creeks, can infect or contaminate animals, vehicles, equipment and people coming into contact with it.

FMD virus has been shown to remain viable in animal manure for the following periods (Bauer & Eissner 1972, Rozov & Andryunin 1972, Callis et al 1980):

- dry manure — 14 days
- moist manure — 8 days
- manure mounds or piles 30 cm high — less than 6 days
- liquid manure — 34–42 days at 12–22 °C
- water from pen washings — 21 days at 17–21 °C.

FMD virus may remain viable in the urine of susceptible species and has been recorded as persisting in urine for up to 7 days (Cottral 1969); persistence of virus in urine will depend on temperature and pH.

## **Biological products (e.g. vaccines)**

Outbreaks of FMD have been traced to the use of contaminated biological products, including inadequately inactivated FMD vaccines, vaccinia vaccine, hog cholera vaccine and pituitary extract.

## **Nonsusceptible animals**

Nonsusceptible vertebrate animals can act as mechanical vectors for FMD virus through the movement of contaminated soil or other organic material.

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<sup>19</sup> Manual of the International Embryo Transfer Society (4th edition, 2010)

## People

People can act as mechanical vectors for FMD virus, by carrying the virus on their boots, clothes or skin. Spread has been associated with veterinarians, vaccinating teams, livestock owners and rodent exterminators.

It is also possible for the virus to be present in the nasal passages of people. People examining the head area of clinically affected pigs (which have higher levels of virus in their air passages than other species) could potentially harbour FMD virus in their nasal cavities. Usually, the period is 4–5 hours, but virus was recovered after 28 hours in one person (Sellers et al 1970). The likelihood of prolonged persistence (more than 24 hours) of FMD virus in the human nasal cavity has been assessed as low (Armstrong et al 1967).

Rarely, infection in people can occur through wounds to the skin following handling of diseased animals or the virus in the laboratory, or through the oral mucosa by drinking infected unpasteurised milk. Person-to-person transmission has never been reported; however, vesicles from affected people do contain virus (Armstrong et al 1967). FMD is not a food safety concern. It cannot be transmitted to humans through consuming commercially produced meat, milk or dairy products, which would continue to be safe to consume in an FMD outbreak.<sup>20</sup>

## Crops, grains, hay, silage and mixed feeds

Animals, especially pigs, might become infected with FMD virus by ingestion of contaminated forage, grain, animal products or water, or by licking contaminated objects.

The likelihood of contamination of crops, grain, hay and so on by infected feral or domestic animals depends on how recently the infected animals were present, the number of infected animals, species, virus excretion, environmental conditions (which influence virus viability), and management and grazing patterns (Auty et al 2019). Feed processing, such as ensiling and mixing, may also influence the concentration of viable virus in the resultant feed. A case-by-case release and exposure assessment would assist in assessing the risk that crops, grains, hay and so on would play in the epidemiology of the outbreak. Factors for consideration include:

- time since detection of FMD
- declared area where the feed is produced
- proximity of the crop to IPs and dangerous contact premises
- access of FMD-susceptible feral animals to crops
- climatic conditions
- type of material contaminated.

FMD virus is reported to remain viable for:

- up to 74 days on pasture at 8–18 °C and high relative humidity
- 26–200 days in soil, hay or straw, depending on storage or climatic conditions (Morgan 1993)
- 15 weeks on hay (APHIS 1980, McKercher & Callis 1983)
- 20 weeks on bran (APHIS 1980, McKercher & Callis 1983).

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<sup>20</sup> [www.foodstandards.gov.au/consumer/safety/Pages/Animal-diseases,-human-health-and-food-safety.aspx#:~:text=FMD%20is%20not%20a%20food%20safety%20concern.%20It,foot%20and%20mouth%20disease%20which%20commonly%20affects%20children](http://www.foodstandards.gov.au/consumer/safety/Pages/Animal-diseases,-human-health-and-food-safety.aspx#:~:text=FMD%20is%20not%20a%20food%20safety%20concern.%20It,foot%20and%20mouth%20disease%20which%20commonly%20affects%20children)

## **Vehicles, including empty livestock transport vehicles**

FMD virus can be readily spread on contaminated vehicles, including milk tankers.

Vehicles used to transport infectious preclinical<sup>21</sup> or clinical animals can become contaminated and serve as a source of infection for other susceptible species, as well as acting as an intermediate fomite vector.

Vehicle surfaces that are difficult to decontaminate (e.g. porous surfaces) may harbour FMD virus and serve as a source of infection for naive animals.

Milk tankers can become contaminated with FMD virus during an outbreak through:

- collection of FMD virus–contaminated milk from a dairy farm during the preclinical phase of the disease
- collection of FMD virus–contaminated milk from a dairy farm during the clinical phase of the disease, if the farmer has either not recognised the clinical signs or not reported them to the relevant authorities
- physical contamination of the exterior of the vehicle (e.g. tyres); milk handling equipment (e.g. milk hose, milk sample bottles); or the driver’s hands, clothing and footwear with FMD virus.

The risk of contaminated milk transported by a milk tanker forming a plume (during filling or venting in transit) that would constitute a high enough dose of FMD virus to be infective to susceptible animals is thought to be negligible (Bestbier 2016).

## **Equipment, including personal items**

FMD virus can be readily spread on contaminated equipment, boots and clothing. For example, FMD virus in tissue fluids or blood allowed to dry on various materials and kept indoors at room temperature may remain infective for 11 weeks on boot leather and 13 weeks on rubber boots (APHIS 1980, McKercher & Callis 1983). FMD virus has also been reported to remain viable for up to 35 days on cardboard, wood or metal contaminated with serum, blood or tissue and up to 398 days on wood contaminated with fat (Gailunas et al 1969). It is also reported to persist for 26–200 days in sacking, depending on storage or climatic conditions (Morgan 1993).

## **Arthropod vectors**

No arthropod vector has been identified as being important in the spread of FMD virus (Bachrach 1968).

## **2.4.3 Factors influencing transmission**

### **Host species**

Species differ in their likelihood of infection with FMD virus, their susceptibility to infection by different routes and the amount of virus subsequently shed (Gloster et al 2008; see Table 2.1).

Pigs are the major amplifying host for FMD. Although pigs are primarily infected by ingesting FMD virus–contaminated feed, they produce large amounts of virus in respiratory aerosols (Alexandersen et al 2003). Thus, spread of FMD from an infected piggery could be rapid and widespread, allowing the disease to gain a substantial foothold before the first clinical cases are diagnosed. Pigs can excrete significantly more FMD virus into the air than cattle (Donaldson et al 1970).

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<sup>21</sup> Animals can excrete FMD virus up to 2 days before appearance of clinical signs. The virus can also be shed in milk up to 4 days before appearance of clinical signs.

**Table 2.1 Strain differences in amount of airborne FMD virus emitted (infectious units per minute)**

FMD strain	Cattle	Sheep	Pigs
O <sub>1</sub>	57	43	7 140
O <sub>2</sub>	4	1.4	1 430
A <sub>5</sub>	93	0.6	570
A <sub>22</sub>	7	0.3	200
C <sub>Noville</sub>	21	57	42 860
C <sub>Lebanon</sub>	6	0.4	260

1 infectious unit = 1.4 TCID<sub>50</sub> (see Glossary)

Source: Adapted from Donaldson et al (1970)

The significantly higher respiratory tidal volume of cattle makes them more susceptible to aerosol infection with FMD virus than sheep or pigs — sheep have one-quarter, and pigs one-twelfth, the infection risk of cattle. Cattle are considered the best indicator species for the presence of FMD virus in an area.

Larger cattle herds are more likely to be infected with FMD virus than smaller ones because of the greater probability that at least one animal will inhale an infectious dose (Garner & Cannon 1995). Cattle feedlots, because of their size and species susceptibility, pose a significant risk of becoming infected, and the risk of the infection spreading through the feedlot is increased if destruction of infected animals is delayed.

*Bos indicus* cattle are reported to be less susceptible to infection with FMD virus than other species. Expression of FMD in *Bos indicus* breeds can also be significantly milder, making detection of the disease more difficult.

### Livestock production and marketing

Marketing and production systems in Australia can result in rapid dispersal of animals over wide areas. The ability to trace livestock movements and products is critically important to the early control of an FMD outbreak. The movement patterns of sheep may be particularly important, because infected sheep can show only mild, or no readily identifiable, clinical signs.

Extensively managed cattle and sheep in pastoral areas of Australia are observed less frequently than intensively managed livestock. They may also contain a high proportion of zebu breeds, which tend to show milder signs. FMD might therefore be harder to detect, and spread slowly and insidiously. In such enterprises, African experience suggests that spread of FMD is more likely in the dry season, when animals congregate at watering points. On the other hand, infection with FMD virus is less likely to be maintained because low stocking densities provide limited opportunity for spread, and the disease could die out naturally.

In Australia's more intensively managed areas, livestock populations are denser and in closer contact. Local spread may play a significant role in transmission between herds or flocks in these areas. Frequent stock movements between individual enterprises and saleyards would facilitate rapid spread of FMD virus over wide areas. Windborne spread of FMD virus might also occur over greater distances in climates that are cooler and wetter. The chances of a rapidly spreading outbreak of FMD are thus higher, but the disease might be more readily detected.

High-risk enterprises, such as intensive piggeries and feedlots, may influence the spread of FMD virus within a region. Large piggeries may have an increased risk of transmission because pigs act as amplifiers of

FMD virus. Feedlots, which also have large concentrations of animals, represent a special hazard, as the animals are likely to be more easily infected through aerosols than are extensively grazed animals.

In some areas, feral animals (pigs, buffalo, goats, sheep and cattle) are in close contact with livestock, and should therefore be considered for investigation as to their role in the epidemiology of an Australian outbreak.

## **2.5 Diagnostic criteria**

### **2.5.1 Clinical signs**

A wide range of clinical syndromes of FMD can occur, ranging from inapparent disease with minimal lesions to severe clinical disease; the classical signs and lesions of FMD are described below. Clinical signs in younger naive stock tend to be more severe, unless the animal is protected by maternal antibodies.

#### **Animals**

##### **Cattle**

A guide to estimating the age of lesions caused by infection with FMD virus in cattle and pigs is presented in Appendix 3.

In cattle, the earliest clinical signs of FMD are dullness, poor appetite and a rise in temperature to 40–41 °C. In dairy cows, milk yield drops considerably. Profuse salivation, nasal discharge and lameness may be observed, depending on the stage of infection. Affected animals move away from the herd and may be unwilling or unable to stand. Lethargy and rapid loss of condition are also features of the disease.

Vesicles may appear inside the mouth, on the tongue, cheeks, gums, lips and/or palate. At first, they are small, blanched areas. Fluid accumulates under these areas to form vesicles, which develop quickly and might reach 30 mm or more in diameter, especially on the dorsum of the tongue. Two or more vesicles can join to form a larger one, sometimes covering as much as half of the surface of the tongue. However, intact vesicles are not often seen, because they usually burst easily and within 24 hours, leaving a raw surface fringed by blanched flaps of epithelium. Alternatively, the fluid may drain, leaving an intact area of blanched epithelium. There may be profuse, frothy saliva around the mouth and, at intervals, a smacking or sucking sound. The lesions heal rapidly over several days.

Vesicles may form between the claws of the feet and along the coronary band. Initially, they appear as areas of blanched epithelium, and the underlying vesicles may not be obvious unless the epithelium is torn away. Foot lesions may also be masked by dirt, and careful examination of feet is needed in muddy conditions. There might be signs of pain in the feet; when forced to rise, the animal might walk gingerly and occasionally shake a leg as if to dislodge an object wedged between the claws. As the lesions heal, separation of the heels along the coronary band can occur. From 2 to 6 weeks after infection, the feet appear to be 'slippered' as the horn of the heel separates and may be easily removed from the underlying corium. Cracks in the heels can take a long time to heal in some animals, causing chronic lameness and weight loss.

Lesions can also occur on the teats and udder, and reduced lactation, mastitis and abortion are common. Aborted calves can contain FMD virus (Ranjan et al 2016).

Mortality in adults is usually low to negligible, but up to 50% of calves might die due to cardiac involvement and complications such as secondary infection, exposure or malnutrition.

In tropical areas, some recovered cattle can develop a heat intolerance syndrome, accompanied by long, thick hair (hirsutism) and generalised ill-thrift (Ghanem & Abdel-Hamid 2010, as cited in Abbas et al 2012; Spickler 2014). They have been called 'hairy panthers'.

The disease can also be mild or inapparent, especially in *Bos indicus* breeds.

## **Pigs**

In pigs, the main sign is lameness, although this can be masked if the affected animals are on soft ground. Vesicles form around the top of the foot, on the heels and between the claws. The epithelium may appear blanched, or raw and ragged at the coronary band at the top of the hoofs. Affected pigs prefer to lie down and, when made to move, hobble painfully and squeal loudly. The feet might become 'thimbled' as the horny layer separates and is easily removed from the underlying corium. After several days, granulation tissue and new horn growth will be evident.

Snout lesions may develop, but quickly rupture, and mouth lesions are difficult to see. Vesicles can develop on the teats and spread over the skin of the mammary glands. Abortion is common and might even be the presenting clinical problem. Affected pigs may have a reduced appetite, become lethargic and huddle together. They may develop an increased temperature, but this feature is inconsistent (Spickler 2014). Significant mortality can occur in piglets up to 14 weeks of age, due to cardiac involvement (Spickler 2014).

## **Sheep and goats**

In sheep and goats, the disease is usually mild with few lesions, and those lesions can easily be misdiagnosed as endemic diseases such as scabby mouth or footrot. Severely affected animals can, however, succumb to sudden, severe lameness affecting one or more feet. Vesicles form around the top of the foot and between the claws. They are not often noticeable in the mouth but may develop on the tongue and dental pad. Vesicles can also occur on the teats, and rarely on the vulva and prepuce, causing a reluctance to mate (Spickler 2014). Affected sheep look sick and are reluctant to stand. Milk yields can be expected to fall in commercial dairy goats and sheep (Kitching & Hughes 2002). Numerous abortions, along with mortality in lambs due to heart failure, can occur in some outbreaks (Spickler 2014). Aborted lambs may contain FMD virus (Spickler 2014).

During the 2001 epidemic in the UK, clinical signs in sheep were sometimes so mild that the presence of the disease was revealed only by very close examination of all the sheep in a flock. Monitoring of raised temperatures was also used in the UK to determine FMD infection in sheep. The mild or subclinical expression of the disease in sheep is a significant risk factor for spread of the disease.

## **Deer**

The severity of the disease in deer can vary from mild or inapparent in some species to more severe in others. In Australia, although unlikely, it is possible that feral deer could play a role in the spread of disease to domestic animals under certain conditions (Bunn 2013).

In deer examined in the UK in 2001, the appearance and distribution of lesions were similar to those in sheep — in the mouth and on the feet. Viraemia and seroconversion were more reliable indicators of infection than the presence of clinical lesions.

## Ageing of lesions

Understanding the age of lesions in FMD-affected animals can help identify the time of FMD virus introduction to the premises, and so inform tracing priorities and epidemiological assessment of the incident (see Section 4.3.5).

The descriptions in Appendix 3 for estimating the age of FMD lesions in cattle and pigs are based on those of Kitching & Mackay (1995), as referenced and illustrated in *Foot and mouth disease ageing of lesions* (DEFRA 2005) and *A field guide to estimating the age of foot-and-mouth disease lesions* (EUFMD nd). In general, oral lesions are often easier to use for ageing because lesions on the feet are often damaged, and may be obscured by dirt, faeces and other organic material. The guides also show lesions in sheep; however, as disease in sheep is often milder, with fewer lesions, ageing the lesions may be more challenging in this species.

## 2.5.2 Pathology

### Gross lesions

The gross lesions observed in FMD are primarily vesicular lesions on the feet, mouth, muzzle, nose and udder. A detailed description of vesicles and their ageing is provided in Appendix 3.

Additional gross lesions can include erosions on rumen pillars at postmortem, and grey or yellow streaking in the heart from degeneration and necrosis of the myocardium in young animals of all species ('tiger heart') (OIE 2013, Spickler 2014).

Apart from identifying vesicles and heart lesions, pathological examination is important only in the differential diagnosis of other diseases.

### Microscopic lesions

Viral replication in epithelial tissues occurs in the stratum spinosum. It results in the accumulation of intracellular and extracellular fluid, leading to the development of a vesicle. Sometimes, early rupture of this layer results in escape of fluid and a desiccated lesion. Other important secondary sites of replication include the ruminal lymph nodes and heart. In young animals, sudden death from myocardial necrosis might occur before the vesicles develop.

### Pathogenesis

The most common route of infection, especially for ruminant species, is by inhalation of virus in droplets or aerosol. The virus adheres to the mucosa of the respiratory tract and primarily replicates in epithelial cells of the pharyngeal mucosa-associated lymphoid tissue crypts. It then undergoes widespread replication in pneumocytes in the lungs, resulting in a sustained viraemia (Arzt 2010) and spread to secondary sites, such as the epithelium, mucosa, mammary gland and myocardium (Neumann et al 2017). Pigs infected by the oral route undergo primary infection and replication of the virus in the oropharyngeal tonsils (Stenfeldt et al 2014).

## 2.5.3 Differential diagnosis

The following diseases and conditions should be considered in a differential diagnosis of FMD:

## Endemic

- bluetongue (some serotypes)
- mucosal disease
- bovine papular stomatitis
- bovine ulcerative mammillitis
- pseudocowpox
- bovine malignant catarrh
- contagious ecthyma ('scabby mouth')
- infectious bovine rhinotracheitis/infectious pustular vulvovaginitis
- scalding, wetting, contact dermatitis
- photosensitisation
- mouth lesions in pigs from hot feed
- laminitis, hoof abscess, footrot (e.g. from bad floors, new concrete, mud).

## Exotic

- swine vesicular disease
- vesicular stomatitis
- vesicular exanthema
- senecavirus A
- rinderpest<sup>22</sup>
- peste des petits ruminants.

## 2.5.4 Laboratory tests

### Samples required

State veterinary diagnostic laboratory staff will advise on the recommended samples and sampling techniques. Specimens essential for the rapid confirmation of FMD include (also refer to Table 2.2) the following.

*For agent detection and characterisation* — fresh samples:

- from live animals
  - vesicular fluid in a sterile container
  - epithelial coverings, flaps or swabs of vesicular lesions in phosphate-buffered gelatin saline (PBGS) or, in an emergency, sterile phosphate-buffered saline (PBS)
  - whole blood
  - oesophageal–pharyngeal fluid (via probangs)
- from dead animals (in addition to samples from live animals, if available)
  - tissue samples, including lymph nodes (especially those around the head), thyroid, adrenals, kidney, spleen and heart, and any other observed lesions.

*For serology* — serum.

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<sup>22</sup> OIE Resolution 18/2011 recognises that all 198 countries with rinderpest-susceptible animal populations are free from the disease.

*For histopathology* (for differential diagnosis) — samples in formalin of lesion tissue (as above), including lesions of the upper gastrointestinal tract.

Note that two samples of each of the above should be taken, with the second sample held in the jurisdiction in case further investigation is required. For further information, see the **AUSVETPLAN Management manual: *Laboratory preparedness***.

### **Sampling feral animals**

Sampling wild or feral animals can present several challenges that make the usual approach to sampling impracticable. Remote locations, lack of a cold chain, animals found dead and untrained operators are all potential limitations. Several alternative approaches are possible to ensure that testing can proceed under challenging circumstances.

Sampling of blood or peritoneal fluid from animals found (recently) dead or shot is expected to be enough to detect acute infection.

Conventional approaches to sampling, if possible, are always preferred. If conventional approaches are not available, swab sampling in viral transport media is preferred to card-based methods.

Proprietary swabs such as the PrimeStore, COPAN eNAT, COPAN FLOQSwab and GenoTube swabs, or Whatman FTA cards, provide a method for sample collection that may inactivate, stabilise and preserve viral RNA without the need for refrigeration of the sample.

It is important to be aware that, although some of these sampling systems claim inactivation of the agent (some do not), this should not be assumed to be 100% effective. Adequate biosecurity measures must be taken in transporting all samples, regardless of whether the sampling system claims inactivation.

### **Transport of specimens**

Specimens should be submitted in accordance with agreed state or territory protocols. Specimens should initially be forwarded to the state or territory laboratory for appropriate analysis, and assessment of whether further analysis will be required by the CSIRO Australian Centre for Disease Preparedness (CSIRO-ACDP), Geelong.

If the state or territory laboratory deems it necessary, duplicate samples of the specimens should be forwarded to CSIRO-ACDP for emergency disease testing, after the necessary clearance has been obtained from the chief veterinary officer (CVO) of the state or territory of the suspect case, and after the CVOs of Victoria and Australia have been informed about the case and the transport of the specimens to Geelong (for the first case). Sample packaging and consignment for delivery to CSIRO-ACDP should be coordinated by the relevant state or territory laboratory.

FMD virus is a security sensitive biological agent (SSBA). Entities handling and transporting samples known or suspected to contain FMD virus should ensure that they meet their obligations under the SSBA Regulatory Scheme.

For further information, see the **AUSVETPLAN Management manual: *Laboratory preparedness***.

### **Packing specimens for transport**

Unpreserved tissue and blood specimens should be sent with water ice or frozen gel packs (dry ice or liquid nitrogen if a delay of more than 48 hours is expected) in a specimen transport container specified under

the International Air Transport Association Dangerous Goods Regulations. Unless oesophageal–pharyngeal fluid samples will arrive at the laboratory on the same day, they should be frozen, preferably in liquid nitrogen, very soon after sampling and packed with dry ice for transport.

For further information, see the **AUSVETPLAN Management manual: *Laboratory preparedness***.

## 2.5.5 Laboratory diagnosis

### Networked laboratory approach for emergency animal disease management

The Laboratories for Emergency Animal Disease Diagnosis and Response (LEADDR) network consists of the jurisdictional animal health laboratories from all states and the Northern Territory; CSIRO-ACDP; and the Australian Government Department of Agriculture, Fisheries and Forestry. It does not currently include private, university or industry animal health laboratories. The network reports to the Sub-Committee on Animal Health Laboratory Standards under the Animal Health Committee. The role of the LEADDR network is to allow state and territory laboratories and the National Reference Laboratory to collaborate using harmonised or standardised testing methods and software platforms for targeted management of an emergency animal disease (EAD).

In the event of an EAD outbreak, LEADDR laboratories may be required to carry out testing appropriate to the level of biosecurity and test capability of the individual laboratory.

### CSIRO-ACDP tests

The testing method used by CSIRO-ACDP is shown in Figure 2.1. Further details of tests currently available at CSIRO-ACDP are shown in Table 2.2. They include direct tests such as real-time polymerase chain reaction (PCR) using TaqMan probes as a rapid and reliable diagnostic test. The samples are vesicular fluids, swabs or epithelial tissue. TaqMan-based real-time PCR takes 4 hours. This test is not serotype-specific and can only confirm the presence of FMD virus nucleic acid.

CSIRO-ACDP can also perform enzyme-linked immunosorbent assays (ELISAs) that can detect FMD virus antigens in vesicular fluid or homogenates of epithelial tissue from lesions. These tests are used initially with new samples to provide serotype-specific results; they provide results within 3–4 hours. A negative result does not confirm the absence of FMD virus.

Virus isolation in cell culture is useful for specimens with small amounts of FMD virus, to amplify the virus for subsequent characterisation and strain differentiation. This procedure takes 24–48 hours, or longer if passaging is required. In samples with larger amounts of virus, characterisation may be possible without the need to amplify the virus in cell culture.

Antibodies to the whole virus or nonstructural antigens appear in the serum 7–10 days after infection or vaccination. Several ELISA-based tests can be used to detect these antibodies. These tests are used to differentiate between infection-induced and vaccine-induced antibodies (DIVA tests;<sup>23</sup> see Table 2.2).

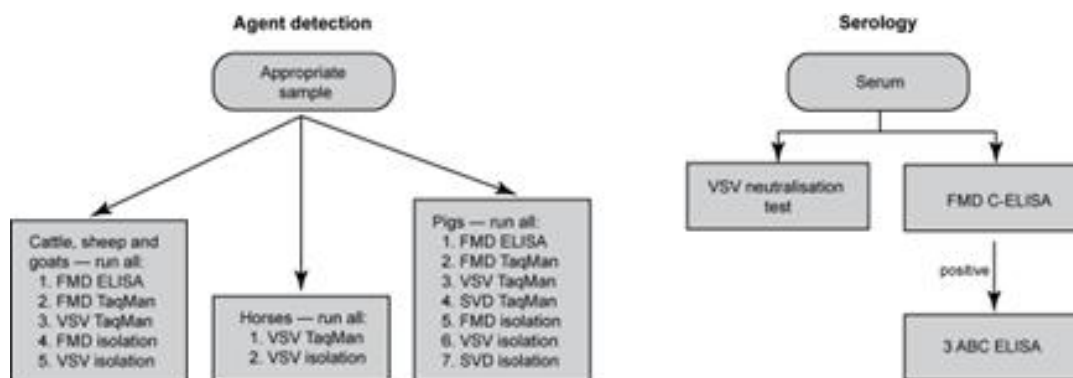
Additional diagnostic tests include sequencing and electron microscopy. Nucleotide sequencing of selected genes or whole genomes can be used in molecular epidemiology.

Animal infection or transmission is rarely used for diagnosis, having been replaced by the more efficient and sensitive *in vitro* procedures described above.

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<sup>23</sup> Validated in cattle

**Figure 2.1 The current approach to diagnostic testing at CSIRO-ACDP**



3 ABC ELISA = DIVA test; C-ELISA = competition ELISA; ELISA = enzyme-linked immunosorbent assay; FMD = foot-and-mouth disease; SVD = swine vesicular disease; VSV = vesicular stomatitis virus

**Note:** CSIRO-ACDP treats any vesicular disease exclusion by testing for all appropriate vesicular disease: samples submitted for either FMD, VSV or SVD exclusion will be automatically tested for the other relevant vesicular diseases.

**Table 2.2 Laboratory tests currently available at CSIRO-ACDP for diagnosis of FMD**

Test	Specimen required	Test detects	Time taken to obtain result
<b>Agent detection</b>			
qPCR	Vesicular fluids, swabs or epithelial tissue	Viral RNA	4 hours
ELISA	Vesicular fluids or epithelial tissue	Antigen and serotype identification	3–4 hours
<b>Agent characterisation</b>			
Virus isolation and identification	Tissues	Virus	1–4 days
RT-PCR and sequencing	Tissue or virus isolate	Viral RNA	1–2 days
<b>Serology</b>			
Liquid-phase blocking ELISA	Serum	Specific antibody	1 day
Solid-phase competition ELISA (C-ELISA)	Serum	Specific antibody	1 day
3ABC-ELISA (DIVA test)	Serum	Specific antibody	1 day

DIVA = differentiating infected from vaccinated animals; ELISA = enzyme-linked immunosorbent assay; PCR = polymerase chain reaction; qPCR = quantitative real-time polymerase chain reaction; RNA = ribonucleic acid; RT-PCR = reverse transcription PCR

Source: Information provided by CSIRO-ACDP, 2022 (refer to CSIRO-ACDP for most up-to-date information).

### Other tests

Experimentally, the use of herd tests such as bulk milk testing (Kompas et al 2017) and air filter sampling (Waters et al 2014; Pacheco et al 2015, as cited in Nelson et al 2017) have been identified as potential

means of active surveillance for rapid post-outbreak detection of FMD. In feral pig populations, the use of baited cotton ropes for obtaining oral fluid samples has proven useful (Vosloo et al 2012).

Pen-side tests are another potential area for rapid detection of FMD in infected animals using tests such as portable reverse transcription PCR (RT-PCR), real-time reverse transcription recombinase polymerase amplification (RT-RPA) (Abd El Wahed et al 2013) and reverse transcription loop-mediated isothermal amplification (RT-LAMP) (Waters et al 2014). These tests have experimentally shown high sensitivity in a range of clinical and preclinical samples of infected pigs, sheep and cattle, and of air surrounding infected animals, and may be used for screening surveillance during an outbreak in Australia.

### **DIVA testing**

DIVA tests can be used to detect infected animals in a vaccinated population. They are based on detection of antibodies to nonstructural proteins of the virus. These proteins are only expressed as the virus replicates in the host and are either not present at all or present at very low levels in purified inactivated vaccines.

In Australia, DIVA testing would be based on an ELISA detecting antibodies to a nonstructural protein (3ABC) of the virus. Animals vaccinated with purified inactivated vaccines but not exposed to live virus are less likely to develop antibodies to 3ABC, but may develop antibodies after repeated booster vaccinations. It is important to note that, in animals infected after vaccination, antibodies induced by vaccination inhibit, but do not prevent, replication of the virus. Because the virus replicates at much lower levels, the titres of antibodies to nonstructural proteins such as 3ABC are much lower. As a result, the diagnostic sensitivity for vaccinated animals is lower than for animals infected but not vaccinated. This differential sensitivity must also be considered as part of the sampling strategy. For this reason, the 3ABC ELISA is used on a herd basis. More information is available in Hardham et al (2020).

## **2.6 Resistance and immunity**

In FMD-endemic countries, zebu breeds of cattle (*Bos indicus*) usually show milder clinical signs than introduced European breeds (*Bos taurus*). However, they can still become infected and transmit infection. Camelids, other than Bactrian camels, appear to have a high natural resistance to infection.

The immunity conferred by natural infection and vaccination is largely strain-specific. There is variable cross-protection between strains of FMD virus within the same serotype, and very little to none between different serotypes. Animals can be infected by multiple serotypes.

## **2.7 Vaccination**

Vaccination against FMD has been successfully used in many parts of the world to control the disease because it reduces the susceptibility of vaccinated animals to infection and viral excretion (following subsequent infection of vaccinated animals). Vaccination can be used in several different ways; different vaccination strategies can be used to aid eradication of FMD (see Appendix 4).

The current inactivated vaccines are either aqueous based (with an aluminium hydroxide adjuvant) or single- or double-oil emulsion based. Testing to differentiate between naturally infected and uninfected vaccinated animals (DIVA testing) is available (see Section 2.5.5).

The immune responses of different species to emergency vaccination in the field have not been well reported. Experimentally, the immune response appears to be consistent for cattle, sheep, goats and pigs, with protective immunity achieved within 7 days and often as early as 4 days after vaccination (Barnett & Carabin 2002). Calves born to vaccinated dams will develop better immunity if vaccinated at older than 3 months of age, due to the presence of maternal immunity (Elnekave et al 2016), and using a high-potency vaccine with a booster dose (Çokçalışkan et al 2017).

Even though vaccinated animals may still become infected, clinical signs are generally masked. This is more likely to be an issue where suppressive vaccination strategies are used (see Appendix 4). The incidence of clinical signs is influenced by the interval between vaccination and infection, declining as this interval increases; the match between the outbreak strain and the vaccine strain; the response of the animal's immune system to vaccination; and the vaccine formulation used (Barnett & Carabin 2002). A well-matched vaccine can reduce the risk of infection and the quantity of virus excreted by animals if they do become infected.

Vaccination is a risk factor for development of a carrier state. Cattle and, to a lesser extent, sheep and goats, can become carriers after infection (see Section 2.4.2). Animals that are exposed to infection within a few days of vaccination may become carriers; however, the prevalence of carrier animals in a vaccinated population is generally low. Field evidence suggests that the risk of carriers (other than African buffalo) initiating new infections in susceptible animals is low. The low prevalence of carrier animals in a vaccinated population means that intensive surveillance sampling is required to prove freedom from disease.

Resistance to clinical disease induced by currently available high-potency vaccines wanes after 4–6 months, so vaccination must be repeated at 6-monthly intervals. If oil adjuvant vaccines are used 6-monthly for 2 years, annual revaccination might then be considered.<sup>24</sup>

## 2.8 Treatment of infected animals

No specific treatment is available for FMD virus–infected animals.

## 2.9 Control overseas

When FMD occurs in a country previously free from FMD, the main control measures implemented include quarantine, movement controls, tracing and surveillance, enhanced biosecurity, animal destruction, disposal and decontamination. Vaccination of susceptible animals may be used, with or without destruction of infected and potentially exposed animals (Paton et al 2009, Muroga et al 2012, Byeong-Yong 2015).

The Food and Agricultural Organization of the United Nations and WOAHA provide guidance and support for countries where FMD is endemic to improve their control of FMD through the Global Foot and Mouth Disease Control Strategy,<sup>25</sup> including the Progressive Control Pathway for Foot-and-Mouth Disease (PCP-FMD).

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<sup>24</sup> For further information, see the European Pharmacopoeia (<https://www.edqm.eu/en/european-pharmacopoeia-ph-eur-10th-edition->).

<sup>25</sup> [www.fao.org/3/I9857EN/I9857en.PDF](http://www.fao.org/3/I9857EN/I9857en.PDF)

## 3 Implications for Australia

### 3.1 Potential pathways of introduction

Human-assisted pathways for the introduction of foot-and-mouth disease (FMD) into Australia include the importation of:

- contaminated livestock products and byproducts, including genetic material
- contaminated equipment and clothing
- infected livestock.

Because Australia has strict import conditions in place, the introduction of FMD through the legal importation of these commodities is very unlikely. However, the illegal introduction and feeding of contaminated meat and dairy products to domestic pigs, or access of feral pigs to these products poses a significant risk.

Natural pathways, such as windborne spread of FMD virus to Australia from infected neighbouring countries, are considered to have negligible likelihood, as a result of the distance and prevailing weather conditions.

### 3.2 Social, economic and environmental effects

The economic effects of an outbreak of FMD, even on a small scale, would be enormous to individuals, the farming industry as a whole, and subsidiary and support industries (Buetre et al 2013). Direct effects on Australia's major livestock industries would stem from export market closures, and the disruption to production associated with the disease and response activities. There would be significant flow-on losses to many rural and regional businesses that rely on livestock industry revenue — for example, from the impact of restrictions on the routine movement of livestock in Australia. In addition, it is expected that there would be indirect effects on sectors such as transport, government agencies, sporting and social events, the racing industry, food processors, retailers, stockfeed and animal byproduct industries, and tourism (Matthews 2011).

A large multistate FMD outbreak has an estimated direct economic impact over 10 years of around \$80 billion<sup>26</sup> (in 2020–21 with a 3% discount rate).

A study by the Australian Bureau of Agricultural and Resource Economics and Sciences concluded that:

- over 10 years, a two-state (small) FMD outbreak is estimated to result in
  - direct impact cost, due to revenue losses, of between \$5.6 billion and \$6.2 billion (in 2013 value terms)
  - reduction of 0.03% (\$4.6 billion) in Australia's gross domestic product (GDP).
- for the same time period, a multistate (large) FMD outbreak is estimated to result in
  - direct impact costs of between \$49.3 billion and \$51.8 billion (in 2013 value terms)
  - reduction in GDP by an estimated 0.16% (\$23.6 billion), although it is predicted that some direct competitors will increase production (Buetre et al 2013).

The Productivity Commission estimated that the direct impacts of an FMD outbreak in Australia would result in a 0.5% loss in employment in the first year of the outbreak. The likely fall in agricultural exports

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<sup>26</sup> Estimate by the Australian Bureau of Agricultural and Resource Economics and Sciences in 2022 based on Buetre et al (2013), updating for current industry conditions and adopting the discounting approach outlined in Hone et al (2022)

would be large enough to affect the exchange rate, and the value of the Australian dollar would fall by an estimated 2.5% during the first year and remain below pre-FMD levels for 9 years (Productivity Commission 2002).

### **3.2.1 Social impacts**

The social impacts of an FMD outbreak may arise from loss of livelihood, loss of animals, uncertainty around future earnings and the stigma associated with the disease. There will also be concerns about the welfare of affected animal populations and the humaneness of the response measures applied to them. These factors may affect individuals' mental health and lead to a potential loss of community cohesion in areas that have a heavy reliance on livestock production. Indigenous communities that use feral pigs as a source of food may also be affected.

Overall socioeconomic effects will be influenced by the length of time out of the market, which may depend on the control strategy used and the reaction of international trading partners.

### **3.2.2 Environmental impacts**

Environmental impacts may result from natural causes (e.g. spread of infection between domestic and feral, wild or native animal populations) and from specific disease control measures (Productivity Commission 2002). Appropriate planning, preparation and execution of control measures should assist in minimising short- and long-term environmental impacts.

#### **Impacts on feral, wild and native animals**

Feral, wild and native animal species may become infected with FMD virus and serve as potential reservoirs of infection.

Destruction, disposal and decontamination controls to manage the risk of disease spread within these animal populations may have adverse environmental impacts.

#### **Destruction**

Activities associated with destruction of animals and contaminated items may have adverse environmental impacts. Use of firearms, gases and poisons for animal destruction could have adverse impacts on the environment in terms of air pollution (e.g. localised impacts on air quality from use of gases and firearms), land pollution from waste (e.g. shell casings; destruction of laboratory waste; chemical residues, such as barbiturates, in carcasses) and noise pollution (e.g. firearm blasts).

#### **Disposal**

Disposal of carcasses, animal products (e.g. meat, milk, virus-contaminated items) and wastes associated with response activities (e.g. consumables) is likely to have the most significant environmental impact, in both the short and longer terms. The method of disposal will significantly influence the impact on the environment and the environmental element (e.g. air, land, water) affected.

## Decontamination

Effects of decontamination — including large volumes of water, disinfectants and consumables associated with decontamination (e.g. chemical containers) — may be significant.

## Secondary effects from control activities

Adverse environmental impacts may occur as a consequence of decreased farmer income and reduced discretionary spending towards on-farm soil conservation, salinity reduction, control of invasive plants and animals, and general environmental preservation.

## 3.3 Critical factors for an Australian response

- FMD is one of the most contagious animal diseases. It can affect a wide range of livestock species and causes significant production losses.
- FMD virus–infected animals excrete large amounts of virus.
- FMD is spread most efficiently by the movement of live, infected animals. It can also be spread rapidly over long distances by movements of contaminated animal equipment, vehicles and people.
- Winds carrying FMD virus can spread the disease over considerable distances under suitable climatic and environmental conditions.
- FMD will rapidly spread through high-density populations such as intensive pig operations, feedlots and dairy farms. Pigs excrete large amounts of virus in respiratory aerosols and, as the main amplifying hosts, are extremely important in disease spread.
- Local spread may be a significant transmission mechanism for premises in close proximity to one another (<3 km).
- Infected sheep and goats might show mild or inapparent signs, and therefore may be important in the undetected maintenance and spread of disease.
- Some recovered sheep, cattle and buffalo (but not pigs) can become carriers, for up to 9 months for sheep and 12 months for cattle (although there are some anecdotal reports suggesting that, under exceptional circumstances, a small proportion of cattle can harbour virus in the pharynx for up to 3.5 years). These carrier animal species are unlikely to play a role in the epidemiology of disease but are important in terms of proof of freedom.
- Not all susceptible animals are capable of transmitting disease (e.g. camelids are unlikely to transmit infection).
- Deer are susceptible, but overseas evidence to date suggests that wild and feral populations pose a low risk of transmitting infection to domestic livestock.
- The role of feral species, particularly pigs, in the epidemiology of the disease in an Australian context is unknown.
- Although FMD virus has been isolated from the nose, throat and saliva of people who have had contact with infected animals, the likelihood of prolonged carriage (more than 24 hours) is considered to be low (Wright et al 2010).
- There is no public health risk from consumption of contaminated meat or animal products.
- Although FMD virus can remain viable following pasteurisation, there are no reports of processed milk, or feeding or transport of processed milk or dairy products, causing disease spread during an outbreak.
- Destruction of infected and suspect infected animals should be completed as rapidly as possible to reduce shedding of the virus and spread of disease.

- Vaccination can be used to protect animals from clinical disease, reduce the probability of infection, and reduce the amount of virus excreted if animals become infected.
- Under some circumstances, vaccination may reduce the duration of an outbreak. Some modelling based on specific scenarios suggests that vaccination may reduce the likelihood of a large, prolonged outbreak.

# 4 Policy and rationale

## 4.1 Introduction

### 4.1.1 Summary of policy

The policy is to eradicate foot-and-mouth disease (FMD), and re-establish the FMD-free status of Australia in the shortest possible time, while minimising social, animal welfare, environmental and economic impacts, using *stamping out* supported by a combination of strategies, including:

- an *immediate and ongoing assessment of the epidemiological situation*
- *rapid recognition* and laboratory confirmation of cases
- an immediate *national livestock standstill*<sup>27</sup> following diagnosis or strong suspicion of FMD, so that epidemiological information can be gathered and collated, and the potential extent and possible impacts of the outbreak can be assessed
- *tracing and surveillance* to determine the source and extent of infection (including, as necessary, in feral animals), and to provide proof of freedom
- *implementation of legislated declared areas* for disease control purposes
- application of *biosecurity (including quarantine) and movement controls* over susceptible animals, animal products and byproducts, and fomites — supported by a robust permit system — to minimise spread of infection
- *typing of the outbreak strain of virus and ordering of appropriate vaccine*
- *active industry participation in the response*, including engagement to provide technical expertise and facilitate cooperation
- *valuation and compensation* for animals that have died or been destroyed, or property that has been destroyed for disease control purposes
- *destruction and biosecure disposal* of susceptible animals, property and things on infected premises (IPs), and other premises on a risk-assessed basis
- *decontamination* of IPs, and other premises on a risk-assessed basis
- *decontamination and/or disposal* of fomites to eliminate the pathogen
- *proactive management of animal welfare issues* that arise from the disease or the implementation of disease control measures
- *surveillance and control of feral animal populations*, as appropriate and where practical; hunting may be banned in nominated areas
- *recall* of animal products (e.g. dairy products for animal consumption) that are likely to be contaminated (unless deemed unnecessary by a risk assessment)
- *relief and recovery programs* to minimise animal welfare and human socioeconomic issues
- a *public information campaign*.

Additional measures may be taken if authorities consider that they would be beneficial in containing and managing the outbreak, including:

- *emergency vaccination* to reduce susceptibility of animals to infection and clinical disease, and potentially reduce virus excretion
- *pre-emptive destruction* of susceptible animals to minimise spread of infection

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<sup>27</sup> A national livestock standstill (see Section 4.3.2) is a result of all jurisdictions, in aggregate, applying jurisdictional livestock standstills.

- *zoning and/or compartmentalisation* (where appropriate).

### 4.1.2 Case definition

For the purpose of this manual, a case of FMD is defined as laboratory-confirmed infection with FMD virus in a susceptible animal.

#### Notes:

- Positive serology in the absence of genome or antigen does not constitute a case but warrants further investigation to determine if there is evidence of infection.
- At the time of an outbreak, revised or subsequent case definitions may be developed (with the agreement of the Consultative Committee on Emergency Animal Diseases — CCEAD).

Information on laboratory confirmation of infection and species susceptible to infection is provided in Sections 2.5.4 and 2.2, respectively.

### 4.1.3 Cost-sharing arrangement

In Australia, FMD is included as a Category 2 emergency animal disease (EAD) in the Government and Livestock Industry Cost Sharing Deed in Respect of Emergency Animal Disease Responses (EAD Response Agreement — EADRA).<sup>28</sup> When cost sharing of the eligible response costs of an incident is agreed, Category 2 diseases are those for which costs will be shared 80% by government and 20% by industry.

### 4.1.4 Criteria for proof of freedom

The World Organisation for Animal Health (WOAH) has a mandate from the World Trade Organization to officially recognise FMD-free areas of countries for trade purposes.<sup>29</sup> Any application to WOAH regarding recognition of Australia's FMD status should be based on the WOAH *Terrestrial animal health code* chapters on FMD (Chapter 8.8)<sup>30</sup> and general surveillance (Chapter 1.4),<sup>31</sup> as well as the WOAH FMD questionnaire (Article 1.6.6).<sup>32</sup> The application will require submission of a formal report to WOAH, detailing the eradication procedures carried out, the surveillance program undertaken and the results obtained.

See Section 7 for more details.

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<sup>28</sup> <https://animalhealthaustralia.com.au/eadra>

<sup>29</sup> [www.woah.org/en/what-we-do/animal-health-and-welfare/official-disease-status/](http://www.woah.org/en/what-we-do/animal-health-and-welfare/official-disease-status/)

<sup>30</sup> [www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=chapitre\\_fmd.htm](http://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=chapitre_fmd.htm)

<sup>31</sup> [www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=chapitre\\_surveillance\\_general.htm](http://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=chapitre_surveillance_general.htm)

<sup>32</sup> [www.woah.org/fileadmin/Home/eng/Health\\_standards/tahc/2016/en\\_chapitre\\_selfdeclaration.htm](http://www.woah.org/fileadmin/Home/eng/Health_standards/tahc/2016/en_chapitre_selfdeclaration.htm)

## 4.1.5 Governance

Governance arrangements for the response to EADs are outlined in the **AUSVETPLAN Overview**.

Information on the responsibilities of a state coordination centre and local control centre is available in the **AUSVETPLAN Management manual: Control centres management (Part 1 and Part 2)**.

## 4.2 Public health implications

FMD is not a food safety concern. It cannot be transmitted to humans through consuming commercially produced meat, milk or dairy products, which would continue to be safe to consume in an FMD outbreak.<sup>33</sup>

The human hand foot and mouth disease is not caused by FMD virus but by a coxsackievirus, a member of the *Enterovirus* genus of viruses.

## 4.3 Control and eradication policy

The policy for an outbreak of FMD is to eradicate the disease through stamping out to re-establish the FMD-free status of Australia in the shortest possible time, while minimising social, animal welfare, environmental and economic impacts.

Stamping out will be the default policy initially.

The aim of stamping out is to ensure that IPs are quarantined (to contain infection on the premises) and susceptible animals are destroyed to limit the spread of the virus. Stamping out should be completed as soon as possible. It will be implemented on all IPs, and potentially on dangerous contact premises (DCPs), subject to risk assessment. Animals on suspect premises (SPs) and trace premises (TPs) must be assessed as soon as possible to enable these premises to be reclassified (and appropriate action to be taken). Tracing and surveillance will play a critical role in identifying infected and in-contact animals to determine the extent of the restricted areas (RAs), control areas (CAs) and outside area (OA).

Animals that are considered to be most infective will be given priority for destruction, in accordance with the **AUSVETPLAN Operational manual: Destruction of animals**. Animals showing clinical signs should be destroyed first to reduce virus excretion. Where possible, infected pigs should be destroyed before cattle, and cattle before sheep (based on the volumes of virus excreted by each species). Clinically infected animals will be followed by susceptible animals presenting the next highest risk, such as those in direct contact with clinical cases.

The primary objectives of the policy are to prevent:

- contact between infected and susceptible animals
- production of large volumes of virus by infected animals
- indirect spread of virus by people and fomites.

These objectives can best be achieved by implementing several strategies, including:

- rapid diagnosis and laboratory confirmation of cases
- biosecurity (including quarantine) and movement controls over high-risk premises and declared areas

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<sup>33</sup> [www.foodstandards.gov.au/consumer/safety/Pages/Animal-diseases,-human-health-and-food-safety.aspx#:~:text=FMD%20is%20not%20a%20food%20safety%20concern.%20It,foot%20and%20mouth%20disease%20which%20commonly%20affects%20children](http://www.foodstandards.gov.au/consumer/safety/Pages/Animal-diseases,-human-health-and-food-safety.aspx#:~:text=FMD%20is%20not%20a%20food%20safety%20concern.%20It,foot%20and%20mouth%20disease%20which%20commonly%20affects%20children)

- valuation and compensation for animals that have died or been destroyed, or property that has been destroyed for disease control purposes
- destruction and biosecure disposal of infected animals and potentially contaminated animal products, byproducts and wastes
- management of animal welfare
- tracing and surveillance
- effective public information and industry engagement.

Zoning or compartmentalisation for international trade may also be considered. The potential for feral and wild animals to compromise containment and eradication needs to be assessed and appropriately managed.

Implementation of these strategies would be supported by ongoing epidemiological assessment of the incident.

The strategic use of emergency vaccine, in accordance with international standards, may be considered if the disease spreads, or is forecast to spread, beyond the limit of available resources to contain it. Use of emergency vaccine could protect areas with high animal concentrations, limit infection and minimise virus excretion, minimise the number of animals that may need to be destroyed, or reduce the likelihood of a prolonged or large outbreak. Pre-emptive vaccination in the absence of an outbreak of FMD in Australia will not occur.

Where eradication (with or without vaccination) is impractical or infeasible, a long-term control program may need to be considered through close consultation between industries and governments (see Section 4.4).

### **4.3.1 Epidemiological assessment**

Epidemiological investigation or assessment draws on multiple sources of information to build understanding of the disease and how it is behaving in an outbreak. This helps inform response decision making.

The key objectives for an epidemiological assessment will be to identify the:

- spatial distribution of IPs, DCPs, SPs, TP and dangerous contact processing facilities (DCPFs), and premises with susceptible animals
- spatial distribution of infected and susceptible wild animal populations
- likely date and source of introduction and establishment of FMD virus
- appropriate tracing windows
- prevalence of infection
- possible variations in presenting signs seen under Australian field conditions from those previously recorded for the outbreak strain
- pathways of spread and their risk profiles
- risk factors for the presence of infection and susceptibility to disease
- likely size and duration of the outbreak, using modelling where available.

Epidemiological assessment, and tracing and surveillance activities in an EAD response are interrelated activities. Early findings from tracing and surveillance will be inputs into the initial epidemiological assessment (e.g. considering the temporal and spatial distribution of infection). The outcomes of the epidemiological assessment will guide decisions on subsequent tracing and surveillance priorities, as well as selection of other appropriate response measures (e.g. application of movement controls). Ongoing

epidemiological assessment will aid evaluation of the continued effectiveness and value of response measures, and will contribute evidence to support any later claims of disease freedom. See Section 7 for further information.

Genomic sequencing may aid an epidemiological understanding of the temporal and spatial spread of infection. It may also provide useful information to support ongoing epidemiological assessment and choice of evidence to support proof of freedom.

#### **4.3.2 Biosecurity and movement controls (including quarantine)**

In a response to FMD, biosecurity and movement controls (including quarantine) will be immediately imposed on all premises and declared areas on which infection or contamination with FMD virus is either known or suspected. The implementation of biosecurity and movement controls will be underpinned by the use of legally declared areas and application of premises classifications (see Section 5).

Movement controls and enhanced biosecurity requirements will be implemented to minimise the risk of spread of FMD, particularly into uninfected areas and populations. In accordance with Section 6, controls may be placed on the movement of infected or potentially infected animals and contaminated or potentially contaminated things (including semen and embryos; products and byproducts; vehicles; equipment; people; nonsusceptible animals; crops, grains, hay, silage and mixed feeds; and manure/effluent).

Biosecurity controls to prevent contact between susceptible feral and domestic animals should be implemented, where practical, to avoid infection of domestic animals from feral animals and vice versa. Other disease control strategies that may be implemented for feral animals include:

- a ban on most permitted hunting (only hunting with authorisation from government authorities will be allowed)
- culling of feral populations
- control of human-assisted movements of potentially infected feral animals and carcasses, and associated fomites (e.g. hunting equipment, hunting dogs, vehicles, equipment).

Also refer to the **AUSVETPLAN Operational manual: *Wild animal response strategy***.

Aggregations of live susceptible animals (e.g. shows, scales operations, saleyards) will be prohibited in the RA and CA. Operation of aggregation points in the OA should be at the discretion of the jurisdiction. If they are allowed to operate, the animals must be held for a minimal time, and be for slaughter only.

Enhanced biosecurity will be encouraged on all premises with susceptible animals, including those outside declared areas.

Detailed guidelines for classifying (and reclassifying) declared areas and premises are provided in the **AUSVETPLAN Guidance document: *Declared areas and allocation of premises definitions in an emergency animal disease response***.

#### **Site-specific biosecurity and movement controls**

All premises on which infection is confirmed (IPs and approved disposal sites — ADSs) or suspected (SPs, TPs, DCPFs and DCPs) will be subject to biosecurity and movement control measures until assessed, controlled or reclassified.

The initial response to strong suspicion or confirmation of the disease in Australia (regardless of jurisdiction) will be the immediate declaration of a national livestock standstill prohibiting all new movements of live susceptible animals unless an emergency permit has been issued. A national livestock standstill is a result of all jurisdictions, in aggregate, applying jurisdictional livestock standstills through relevant state or territory legislation. Although a livestock standstill is intended to be a coordinated approach to movement restrictions across jurisdictions, implementation and revocation of the standstill may vary in timing between jurisdictions.

The decision to declare a national livestock standstill will be made by the National Management Group (NMG), on the advice of the CCEAD.

Additional controls on the movements of potentially infected or contaminated animals, products and fomites may be implemented in declared areas in each jurisdiction. These measures will be determined using available epidemiological information to assess the risk within the state or territory.

The duration of a national livestock standstill will depend on the circumstances of the incident, but will be at least 72 hours. Any decision to extend or lift the national livestock standstill will be made by the NMG, on advice from the CCEAD, based on an assessment of risks, the outcomes of initial tracing, surveillance information and the identified epidemiology of the outbreak.

The national livestock standstill will apply only to FMD-susceptible animals. However, during the livestock standstill, jurisdictions may impose movement controls over susceptible animal products (e.g. meat, milk, carcasses, offal) and equipment.

Section 6.3 provides more details of the movement controls to be implemented during and following a national livestock standstill.

### **4.3.3 Biosafety and biosecurity for personnel**

FMD is not a significant public health risk, but care should be taken to prevent the further spread of FMD virus through movements of people.

Personnel involved in handling livestock and/or potentially contaminated items or areas (e.g. those involved in sampling animals, products or byproducts; or in destruction, disposal and decontamination activities) on high-risk premises (IPs, DCP, DCPFs, SPs, ADSs and TPs) should be considered contaminated. For these personnel, recommended measures for personal decontamination on exit from the premises include a change of clothing and footwear, nose blowing and decontamination of exposed skin.

Where disposable coveralls and footwear are used, these should remain on site and be disposed of in a biosecure manner (see Section 4.3.12). Nondisposable clothing should be laundered and nondisposable footwear decontaminated (see Section 4.3.13).

Work by Wright et al (2010) suggests that the likelihood of FMD virus remaining viable in human nasal cavities 16–22 hours after exposure to infected animals is low. Therefore, the time between people working with animals from different epidemiological units should be 28 hours if appropriate risk mitigation and decontamination measures are adopted. Stand-down periods should not apply for activities conducted with animals in the same epidemiological unit, at the same premises, provided that personnel have had no contact with any other domestic or wild susceptible species between visits.

Recommended controls on the movements of people are provided in Section 6.3.11.

#### 4.3.4 Biosecurity for equipment

Equipment to be used in the handling of livestock or potentially contaminated items or areas (e.g. equipment used in the sampling of animals, products or byproducts; or in destruction, disposal and decontamination activities) on high-risk premises (IPs, DCPs, DCPFs, approved disposal sites — ADSs, SPs and TPs) should be considered contaminated and either disposed of on-site (see Section 4.3.12) or subject to decontamination (see Section 4.3.13).

Recommended controls on the movements of equipment and vehicles are provided in Section 6.3.11.

#### 4.3.5 Tracing and surveillance

Guidance on tracing and surveillance can be found in the **AUSVETPLAN Guidance document: *Tracing and surveillance***.

##### Tracing

Rapid trace-forward (spread tracing) and track-back (source tracing) of risk animals and items from IPs will help identify the source of the disease, the primary case(s), and the location of potentially infected animals and contaminated items. This will help identify the origin of the disease and define the potential extent of disease spread. Confirming a source and date of introduction of infection on the premises is critical to the investigation of an IP, and has significant implications, particularly for forward tracing.

Tracing should include:

- susceptible species
- animal products — meat, offal, milk and dairy products (including any evidence of illegal feeding of prohibited pig feed), wool, skins, hides, semen and embryos, and wastes and effluent
- vehicles
- materials — hay, straw, crops, grains and mixed feed
- people.

Information management systems (e.g. MAX) should be used to support tracing activities, as well as examination of farm records and interviews with farm workers and managers. Databases for the National Livestock Identification System (including PigPass) and documents such as National Vendor Declarations should be used to assist with tracing and epidemiological investigation.

Determining an accurate tracing window (and tracing prioritisation) requires a full epidemiological and clinical investigation. As a guide, when undertaking initial tracing, all forward and backward traces to other properties should be collected for a minimum of 14 days before the likely timeframe or date of onset of the first clinical signs (noting that 28 days — or 2 incubation periods — may be preferred). Forward traces will also need to include up until the time of quarantine being implemented or the day of investigation on the property. A tracing priority will, however, be given to a subset of this timeframe based on assessed risk, and reassessment will be required as new information is obtained.

It is important to estimate the date when FMD virus is likely to have been introduced onto each IP, as this is the date from which forward and backward tracing will be undertaken. The date can be estimated by ageing the oldest lesions on affected animals on the IP (to ascertain the onset of clinical signs) and considering the individual animal's most likely incubation period of FMD (see Sections 2.5.1 and 2.4.1, respectively). It is important to note that multiple other variables must also be considered. The use of lesion ageing in isolation to ascertain the time of virus introduction may result in the true likely infection

period not being identified and traces not being accurately prioritised. The following limitations of and cautions for their use should also be considered:

- The initial infected animal or group may not be detected. This may occur when the clinical signs are subtle or minor, or in operations where surveillance of a herd is less frequent (e.g. extensive operations).
- Lesions that are more than 6 days of age cannot be aged accurately. Other factors (such as disease prevalence within groups or evidence of prior exposure) may give a better indication of the duration of the infection on the property.
- The potential incubation period varies by species, dose and route.
- Noting the long survivability of FMD virus in environments and on fomites, there could be a significant delay between introduction and exposure. Exposure may not always lead to infection.
- The amount of virus an infected individual excretes decreases over time. However, although significant excretion from individuals may occur for a relatively short, time-limited period, the duration of excretion from a herd may be extended (with the forward spread risk therefore increasing with time). Herd-level excretion based on intraherd transmission is used to determine forward spread risk.

Prioritisation of tracing (forward and back) will assist in targeting the highest-risk traces first and may reduce the extent of disease spread. The European Commission for the Control of Foot-and-Mouth Disease (EuFMD)<sup>34</sup> provides the following guidance on FMD tracing priorities, based on international experiences.

#### **Trace-forward (spread tracing) — principles of prioritisation**

Trace-forward activities should be prioritised according to the risk (likelihood and consequence) of FMD spread (see Figure 4.1). Items that have been effectively decontaminated (see Section 4.3.13) or products and byproducts that have been adequately treated to inactivate FMD virus (see Section 4.3.10) may not require further tracing and investigation.

In determining the likelihood of a traced item spreading disease, a spread or transmission pathway analysis (e.g. scenario tree and release assessment) informs all possible transmission pathways and their relative importance. This step is most important in an outbreak situation where the disease is behaving differently from the epidemiological profile described in this manual (e.g. pig-adapted FMD virus).

Forward spread risk arises from four potential sources and each has relevance for forward tracing:

- The original source of infection onto the premises may have transited the premises creating a forward spread risk at any time. Delays in exposure of susceptible animals to the source of infection mean that onward movements of some of the infective source may occur before infection of any animal.
- Animals infected on the premises pose an immediate forward spread risk if moved, regardless of stage of infection.
- Virus excretion from initial infected animals may create forward spread risk following an initial incubation period.
- Subsequent propagation through the herd will result in increasing virus excretion and associated forward spread risk until depopulation.

Once transmission pathway likelihoods are determined, consideration of when the movement occurred relative to the identified trace windows will determine the situation-specific likelihood.

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<sup>34</sup> European Commission for the Control of Foot-and-Mouth Disease, Food and Agriculture Organization of the United Nations, Module 4, *Foot-and-mouth disease real time training course*, Nepal, 2019.

The consequences of each trace-forward for potential further spread are identified and considered, allowing for the:

- geographic area to which the movement has occurred — in general, OA is a more important consideration than CA, which is more important than RA (OA > CA > RA) (see Section 5.1)
- susceptible populations, densities and potential for further spread.

High-consequence traces may be associated with:

- livestock hubs and aggregation points (e.g. markets, saleyards, events) and premises with a high volume of stock movements (e.g. markets, saleyards, feedlots, depots), where subsequent movements present a higher likelihood of disease spread
- processors with multiple suppliers or receivers who may be affected by contamination
- distributors of genetic material (e.g. artificial insemination technicians)
- rare and valuable animals that may be of high genetic value (e.g. seed stock) or are threatened or protected (e.g. in zoological collections).

The infectivity and susceptibility of the species involved in the trace are important, noting that:

- cattle are the main indicator species and are chiefly infected through the respiratory route
- pigs amplify the virus and are chiefly infected through ingestion
- sheep and goats are the maintenance species and are chiefly infected through the respiratory route.

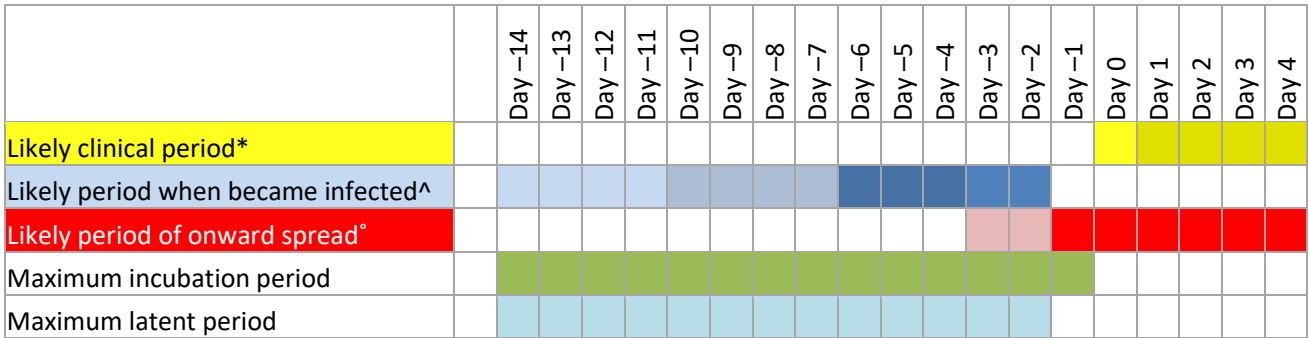
Large susceptible populations (e.g. feedlots, piggeries, dairies) are important because of amplification of the virus (e.g. through pigs), susceptibility through aerosol (e.g. ruminants are more significant than pigs) and spread (e.g. through direct and indirect contact).

#### **Trace-forward (spread tracing) — priorities from an IP**

In individual cattle, virus shedding in body fluids and excretions can begin 2 days before the appearance of clinical signs, although the virus may be shed in milk alone up to 4 days before the appearance of clinical signs. Peak excretion occurs from the appearance of clinical signs and over the following 3 days. Clinical signs include prodromal signs (such as fever and inappetence) that can occur up to 2 days before the appearance of lesions. Transmission is likely to be ongoing, given multiple animals are likely infected.

Figures 4.1–4.3 show the relevant tracing timelines for cattle, pigs and small ruminants.

**Figure 4.1 Tracing timeline for cattle**

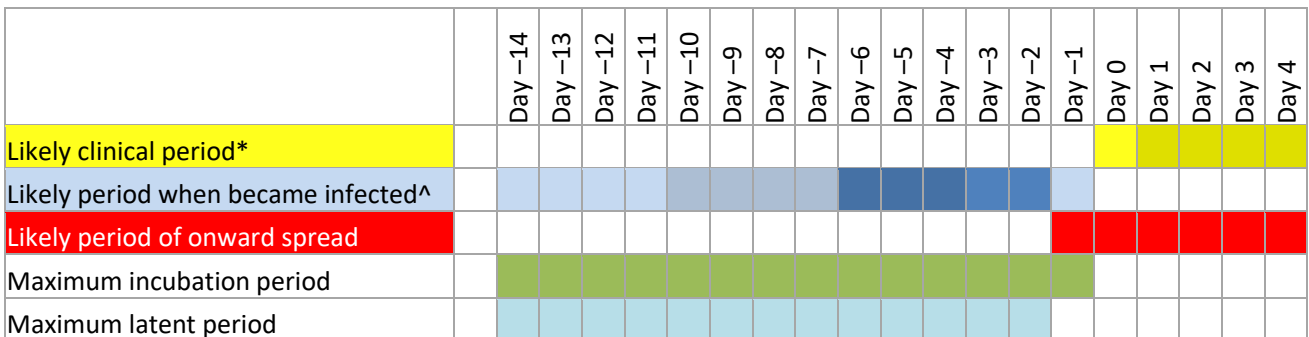


\* Plain yellow indicates prodromal period with mild clinical signs before appearance of lesions.

^ Dark blue indicates most likely period; stippled indicates most likely period for indirect transmission (e.g. first case).

° Pale shading shows shift earlier by 2 days for milk.

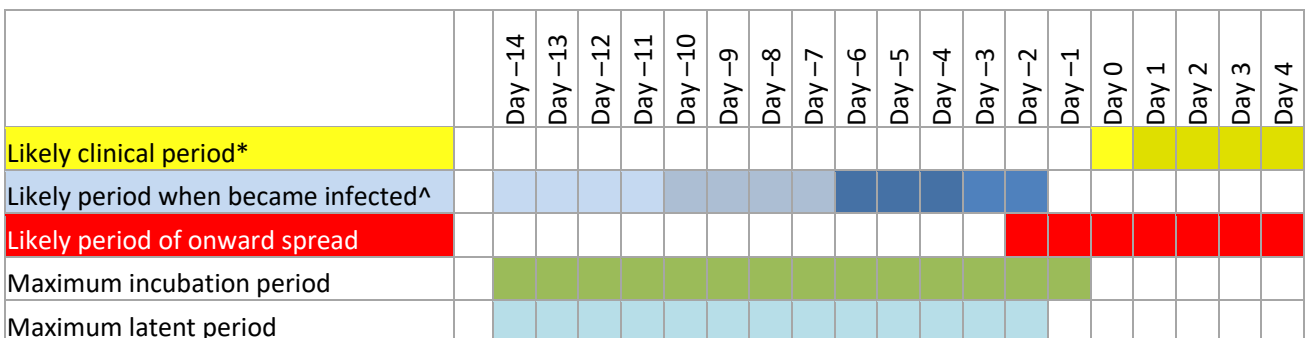
**Figure 4.2 Tracing timeline for pigs**



\* Plain yellow indicates prodromal period with mild clinical signs before appearance of lesions.

^ Dark blue indicates most likely period; stippled indicates most likely period for indirect transmission (e.g. first case).

**Figure 4.3 Tracing timeline for small ruminants**



\* Plain yellow indicates prodromal period with mild clinical signs before appearance of lesions.

^ Dark blue indicates most likely period; stippled indicates most likely period for indirect transmission (e.g. first case).

The following steps should be used to determine the trace-forward priorities from an IP:

1. Identify the trace window. Traces occurring within the trace window are the highest priority. Where resources are limited, prioritising trace-forward from IPs should occur on a risk-assessed basis, taking into account the field epidemiological assessment.<sup>35</sup>
2. Within the trace window, rank the traces by consequence (potential for spread). This includes the destination (e.g. OA > CA > RA) and dispersal potential (e.g. livestock hubs).
3. Within the trace window, rank the species and direct and indirect pathways that are most likely to spread the virus from the IP.

### **Trace-back (source tracing) — principles of prioritisation**

Identification of premises where the disease may have come from is important to identify foci of infection and spread of disease to other premises. Trace-back should be prioritised for investigation according to the risk — that is, the likelihood that the trace is the source of infection and the consequence of spread to other premises from the premises where the trace originated. Items that have been effectively decontaminated (see Section 4.3.13) or products and byproducts that have been adequately treated to inactivate FMD virus (see Section 4.3.10) may not require further tracing and investigation.

In determining the likelihood of a traced item being the source of infection, the movements onto the premises during the trace-back window (the likely time when the first animal on the IP was infected) should be considered. Movements outside the trace window should be lower priority, with priority given to those most likely to transmit disease.

To determine the trace-back window, it is important to estimate the date when FMD virus is likely to have been introduced onto the IP. In the initial stages of an outbreak, an estimated date of introduction to a premises may not yet have been determined. In this case, for each IP, trace-back should be applied for a minimum of 14 days before the onset of clinical signs. The 14 days represents the possible infection window. Within the 14-day trace-back window, priority should be given to tracing of movements onto the IP in the 2–6 days before the appearance of clinical signs on the premises, up until the time that effective quarantine was imposed. If trace-back over the 14-day period does not identify the source of infection, an extended trace-back window should be considered.

Likelihood is also informed by the geographic areas from which the movement onto the IP occurred (OA < CA < RA).

Similar to trace-forward, susceptible populations, densities and potential for further spread should be considered in prioritisation.

High-consequence traces may be associated with:

- livestock and genetic material (e.g. semen)
- hubs and aggregation points (e.g. markets, saleyards, events)
- premises with a high volume of stock movements (e.g. markets, saleyards, feedlots, depots), where subsequent movements present a higher likelihood of disease spread
- rare and valuable animals that may be of high genetic value (e.g. seed stock) or are threatened or protected (e.g. in zoological collections).

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<sup>35</sup> For example, 2 days before (3 days before for milk) to 2 days after clinical signs appeared may be used as a minimum, bearing in mind that this is much shorter than the WOAHI incubation period of 14 days.

The infectivity and susceptibility of the species involved in the trace are important, noting that:

- cattle are the main indicator species and are chiefly infected through the respiratory route
- pigs amplify the virus and are chiefly infected through ingestion
- sheep and goats are the maintenance species and are chiefly infected through the respiratory route.

Large susceptible populations (e.g. beef feedlots, piggeries, dairies) are important because of amplification of virus (e.g. through pigs), susceptibility through aerosol (e.g. ruminants are more significant than pigs) and spread (e.g. through direct and indirect contact).

Figure 4.4 provides a summary of trace-forward prioritisation.



## Trace-back (source tracing) — priorities for an IP

The following steps should be used to determine the trace-back priorities for an IP:

1. Identify the trace window. Traces occurring within the trace window are the highest priority. Where resources are limited, prioritising the trace-back for IPs should occur on a risk-assessed basis, taking into account the field epidemiological assessment.<sup>36</sup>
2. Within the trace window, rank the traces by likelihood.
  - a. Earlier in the response, when the epidemiological situation is less clear, traces from the OA are higher priority than traces from the CA, which are higher priority than traces from the RA.
  - b. As the response progresses and the epidemiological picture becomes clearer, traces originating from the OA are lower priority than traces from the CA, which are lower priority than traces from the RA.
3. Within the trace window, rank the traces by consequence (potential for spread). This includes trace-forward from the source premises to other destinations (e.g. OA, CA, RA) and dispersal potential (e.g. livestock hubs).
4. Within the trace window, rank the species and direct and indirect pathways that are most likely to spread the virus from the source premises.

For example, highest-priority trace-backs are those associated with animal movements (direct contact) within the most likely infection period (within trace window) from an IP. Pig movements and movements from livestock hubs and aggregation points further elevate the priority.

## Surveillance

Surveillance during an FMD outbreak will initially aim to:

- rapidly detect new cases
- identify infected and uninfected populations of susceptible (feral and domestic) animals to define the extent of infection and demonstrate that infection is not present in the CA and OA
- identify the source of infection
- identify linkages between premises (e.g. using genomic epidemiology).

Surveillance throughout the response will contribute evidence to support proof of freedom.

Prioritisation of surveillance should be based on risk, taking into consideration the context of the outbreak. It should consider the likelihood of transmission and the consequences for disease control activities.

General principles are as follows:

- Premises linked to known IPs, DCPs, DCPFs and TPs, and those with animals showing clinical signs consistent with FMD (SPs) may be a high priority. Assessment of the relative surveillance priority of dairy farms that are SPs, TPs and DCPs should take into consideration the likely milk volumes that may accumulate (and require disposal).
- TPs and SPs in areas otherwise believed to be free from infection (the OA and CA) may be a higher priority for investigation than premises in the area where infection is known to be present (the RA).
- Premises with intensive production systems (e.g. feedlots, piggeries) may be a higher priority for investigation than those with extensive production systems.

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<sup>36</sup> For example, 2–6 days before the appearance of clinical signs on the premises up until the time that effective quarantine was imposed is suggested, bearing in mind that this is much shorter than the WOAHP incubation period of 14 days.

- Premises with higher numbers of susceptible animals may be a higher priority for investigation than those with fewer susceptible animals.
- Premises that serve as movement hubs (e.g. saleyards, scales, shows) may be a high priority for investigation.
- Premises with pigs may be a higher priority for investigation than those with cattle; in turn, these may be a higher priority for investigation than those with sheep and goats (based on the amplification of virus by these species and the relative viral loads shed).

The surveillance program will include clinical, serological, virological and/or molecular approaches to the surveillance of susceptible (domestic and feral) animal populations and products. Point-of-care tests, where approved for use, may be used in conjunction with laboratory testing to support surveillance activities.

See Section 7 for further details on surveillance and proof of freedom from FMD.

#### **4.3.6 Zoning and compartmentalisation for international trade**

Where it is not possible to establish and maintain disease freedom for the entire country, establishing and maintaining disease-free subpopulations, through zoning and/or compartmentalisation,<sup>37</sup> may be considered.

In the case of a limited disease outbreak, a containment zone<sup>38</sup> may be established around the areas where the outbreak is occurring, with the purpose of maintaining the disease-free status of the rest of the country outside the containment zone.

All zoning applications would need to be prepared by the Australian Government in conjunction with the relevant jurisdiction(s) and agreed to by the CCEAD. Zoning is usually negotiated after a disease outbreak has begun.

Compartmentalisation applications typically need to be negotiated before an outbreak occurs, and will require input from the relevant industries.

Recognition of both zones and compartments must be negotiated between the Australian Government and individual overseas trading partners. Zoning and compartmentalisation would require considerable resources that could otherwise be used to control an outbreak. Careful consideration will need to be given to prioritising these activities, because the resulting competition for resources could delay the quick eradication of the disease and recognition of disease freedom.

Agreements between trading partners take time to develop, consider and finalise, because of the need to provide detailed information on activities such as biosecurity, surveillance, traceability and diagnostics to support the approach that is developed. An importing country will need assurance that its animal health status is not compromised if it imports from an established disease-free zone in Australia. Trading partners may not accept a zoning or compartmentalisation proposal, regardless of the information provided. Eradication of disease may be achieved before zoning or compartmentalisation applications are finalised.

The WOAH guidelines for zoning and compartmentalisation are in Chapters 4.4 and 8.8 of the WOAH Terrestrial Code.

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<sup>37</sup> With zoning, disease-free subpopulations are defined primarily on a geographical basis. With compartmentalisation, disease-free subpopulations are defined primarily by management practices (such as the biosecurity plan and surveillance practices of enterprises or groups of enterprises).

<sup>38</sup> WOAH defines a 'containment zone' as an infected zone within a previously free country or zone, which includes all suspected or confirmed cases that are epidemiologically linked and where movement control, biosecurity and sanitary measures are applied to prevent the spread of, and to eradicate, the infection or infestation. The Australian Government Department of Agriculture and Water Resources commissioned a report on what would be required for the establishment of containment zones in Australia. This report is available at [www.ausvet.com.au/tools-resources](http://www.ausvet.com.au/tools-resources).

### 4.3.7 Animal welfare

Guidance on managing livestock welfare can be found in the **AUSVETPLAN Operational manual: *Livestock welfare management***.

Because morbidity resulting from FMD may be high, close monitoring and careful management of animal welfare on affected premises will be required.

Adequate space, palatable drinking water and feed that is of suitable quality for livestock are all critical factors in ensuring the health and welfare of animals.

Overcrowding due to the imposition of movement controls on live animals may result in the development of animal welfare issues. This is more likely to be time-critical for intensively managed animals (such as feedlots and piggeries). There is reasonable likelihood of overcrowding leading to welfare issues within 2 weeks of any livestock standstill coming into force (depending on the production system in use; East et al 2014). Managers will need to comply with animal welfare legislation in their state or territory throughout a response and should proactively consider these obligations.

Humane destruction of overcrowded animals on farm or facilitation of livestock movements under emergency permit will need to be considered to avoid compromised welfare. Uninfected animals may need to be euthanased as a consequence of FMD controls, such as an extended shutdown of abattoirs, livestock movement controls or reduced market demand. Euthanasing animals, disposing of carcasses and auditing the number of animals euthanased will be resource intensive. The welfare of producers and staff associated with the emotional toll of animal destruction needs to be considered, as will media management, during mass destruction and disposal events.

In extensive production systems, welfare issues arising from disease control measures are not anticipated in the short term but may occur in the longer term. The welfare of animals on premises affected by disease control measures should be monitored and issues addressed as they arise. For example, animals may need to be moved (either between paddocks or off property) based on available feed and water. This will be more of an issue if movement controls are prolonged. Similar issues may arise when animals need to be moved for shelter (e.g. lambing ewes, recently shorn sheep) or other urgent management needs arise.

Where destruction for welfare purposes is to be considered for cost sharing, see the EADRA guidance documents *Livestock welfare management and compensation principles for parties to the Emergency Animal Disease Response Agreement and Consequential loss*.<sup>39</sup>

### 4.3.8 Vaccination

#### Vaccine availability

Australia does not have any FMD vaccines registered for routine use but has a contract for the supply of certain antigens through the Australian FMD Vaccine Bank under the FMD Production, Storage and Supply Agreement. This will provide vaccines to several FMD strains within 7 business days of notification. Import and emergency use permits<sup>40</sup> are in place for vaccine provided through this arrangement. A cold chain

<sup>39</sup> [www.animalhealthaustralia.com.au/training/emergency-animal-disease-training/guidance-documents/](http://www.animalhealthaustralia.com.au/training/emergency-animal-disease-training/guidance-documents/)

<sup>40</sup> Importation of FMD vaccines requires an import permit from the Australian Government Department of Agriculture, Fisheries and Forestry. Supply and use of the vaccine in Australia require an emergency permit and consent to import from the Australian Pesticides and Veterinary Medicines Authority. Rapid deployment of FMD vaccines requires an early release certificate from the Australian Government Department of Agriculture, Fisheries and Forestry. Importation, distribution, supply, use and disposal of a vaccine that is a genetically modified organism must also be licensed by the Office of the Gene Technology Regulator or permitted under an Emergency Dealing Determination by the minister responsible for gene technology.

distribution company has been contracted to clear the vaccine through customs, store vaccine at its cold store facility, distribute it as requested by Animal Health Australia and provide stock control. The company will also arrange for the return and destruction of unused vaccine doses.

The antigens covered by the Australian FMD Vaccine Bank are selected (and regularly reviewed) to provide broad coverage against potential FMD threats.

### **Vaccination in a response**

Australia maintains flexibility for decision makers to determine a role (if any) for vaccination that is appropriate for the specific outbreak scenario.

In the event of an FMD outbreak, the outbreak strain will be typed as a matter of urgency, to assess whether an appropriate antigen is held in the Australian FMD Vaccine Bank:

- If appropriate vaccine is available, the CCEAD will advise the NMG to order the constitution and delivery of the full supply of doses of appropriate vaccine, regardless of whether vaccination is included in the initial emergency response.
- If the Australian FMD Vaccine Bank does not hold an appropriate antigen, or the number of doses of vaccine in the bank is considered insufficient, Animal Health Australia, under direction from the CCEAD and the NMG, will seek further supplies of vaccine from manufacturers and/or international vaccine stockpiles.

The CCEAD should also provide the first meeting of the NMG with advice on the potential role of vaccination as a control strategy, based on what is known about the epidemiology of the outbreak at the time.

Decisions on the use of vaccination in the response to the incident will then be made by the NMG, on the advice of the CCEAD:

- Vaccination may be considered as part of Australia's response to an outbreak of FMD if the disease spreads, or is forecast to spread, beyond the limit of available resources to contain it, to protect areas of high animal concentrations, and to limit infection and minimise virus excretion.
- Any state or territory proposing the use of vaccination should submit an EAD Response Plan to the CCEAD and the NMG. The EAD Response Plan should discuss the objectives of vaccination, how vaccine is to be used strategically (including the species, location and other factors), biosecurity measures and the logistics of administration.
- Consideration should also be given to how vaccinated animals are to be managed after the outbreak; identification and tracing of vaccinated animals; management of products from vaccinated animals; data management; and surveillance, resourcing, training and logistical requirements.
- The prioritisation of species to be vaccinated will be based on a risk assessment.
- Flexibility is needed in Australia's contingency planning for the management of vaccinated animals, but there is a preference for removal of vaccinated animals to expedite return to international trade.
- Vaccinated animals need to be permanently identified and easily identifiable.
- Identification of individual vaccine bottles is not required, but jurisdictions may do so if they choose.
- Non-veterinarians may be used to vaccinate livestock.

Appendix 4 outlines the different vaccination strategies that may be used, and provides guidance on determining whether vaccination will be used, what strategy(ies) will be used and how vaccinated animals

will be managed. Operational details for the administration and application of a vaccination program are included in relevant nationally agreed standard operating procedures.<sup>41</sup>

#### 4.3.9 Treatment of infected animals

Treatment for FMD is not appropriate under the Australian policy of eradication.

#### 4.3.10 Treatment of animal products and byproducts

A risk-based approach to the use of animal products and byproducts from susceptible animals will be followed.

Different types of rendering and other treatment processes (see Section 2.4.2) will inactivate FMD virus. However, there is concern that inappropriate or incomplete rendering treatments of contaminated products to produce meat meal for pigs may result in disease transmission. As a result, rendered meat meal from high-risk premises (IPs, DCPs, SPs and TPs) will not be allowed into the pig food chain as a feed ingredient, in case quality controls for rendered product are not met and FMD virus is not inactivated.

Treatment, for further marketing, of most products and byproducts from IPs and DCPs is not permitted. This policy will also apply to products originating from animals and premises for a period of at least 14 days before the primary case, or a risk assessment informs otherwise. These products must be disposed of in accordance with Section 4.3.12.

Marketing of products such as wool and other fibres, and embryos may be permitted under special conditions or after treatment, with their movement subject to permit. For further details on movement controls, see Section 6.

Most products from SPs and TPs will not be permitted to be treated and marketed while the SPs remain under suspicion or the trace has not been assessed as negative. This will also apply to products produced during a minimum period of 14 days before the appearance of clinical signs on an SP. However, specified products, such as meat and hides, may be permitted to leave an SP or TP for sale, subject to treatment under permit, or after an agreed period.

Section 6.3 describes recommended movement controls and appropriate permit conditions (including treatment requirements) for meat, semen and embryos, offal, milk and milk products/byproducts, waste products and effluent, vehicles and equipment, wool and other fibres, skins and hides, and stock feeds.

#### 4.3.11 Destruction of animals

Destruction plans should be developed for each premises on which animals may be destroyed. Guidance on destruction methods can be found in the **AUSVETPLAN Operational manual: *Destruction of animals***.

On IPs, all susceptible animals will be destroyed, as this is the quickest means to reduce viral excretion.

Destruction of susceptible animals may also be undertaken in whole or in part on DCPs, subject to risk assessment. The risk assessment should take into consideration the likelihood of exposure to FMD virus, the species affected, FMD vaccination status, animal welfare considerations, and the potential risks of disease transmission (within the premises and to other premises), including the consequences for disease

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<sup>41</sup> <https://animalhealthaustralia.com.au/nationally-agreed-standard-operating-procedures>

control. The risk assessment should also include evaluation of the stocking density for animals at immediate disease risk (see also risk factors below). Depending on the assessed risk, it may be preferable to closely monitor the status of animals on these premises and destroy them only if the premises becomes an IP — rather than pre-emptively cull the susceptible animals.

On SPs and TPs, the priority will be to clarify the status of the premises as quickly as possible. Destruction of animals on these premises is not expected but may be considered on a case-by-case basis to achieve the disease control objectives.

Where destruction of animals is to be implemented, the priority of animals for destruction will be risk based, taking into consideration the risks of disease transmission. The factors to consider in this risk assessment include:

- whether the animals are clinically affected
- whether animals are assessed as having compromised welfare or the potential for compromised welfare
- individual animal factors; for example, potentially dangerous or aggressive animals (e.g. bulls, sows with litters, boars) should be euthanised first; unweaned animals should be euthanased at the same time as their mothers; animals that cannot access feed and water should be euthanased as a matter of priority; and special consideration should be given to animals in parturition or late in pregnancy
- if the animals are not clinically affected, the likelihood of their exposure to FMD virus and volumes of viral excretion; for example, those in direct contact with clinical cases may be a higher priority for destruction than those that have not had direct contact
- the species of animal, and the expected volumes of virus excreted and hence disease transmission risk; as a general guide, pigs excrete more virus than cattle, and cattle excrete more virus than sheep
- the housing or production type, stocking density and location of the animals to be destroyed and those at risk; for example, destruction of low numbers of pigs in a smallholding may be a lower priority than destruction of other species at higher stocking densities on a commercial production premises; in remote areas, low stocking rates and low contact rates will mean that rapid spread is unlikely in extensively grazed animals, except at the end of the dry season when animals congregate around waterholes
- whether the animals have been vaccinated and the effect vaccination may have on volumes of virus excretion if the animals are infected
- other implications for the response if the animals are not destroyed (e.g. disposal of product such as milk from dairy animals).

If FMD is diagnosed in extensive production areas, special control measures, such as aerial shooting<sup>42</sup> without disposal, might be needed where logistical considerations do not allow the rapid destruction and disposal of animals using traditional methods and techniques (e.g. herding into yards or races for humane destruction before disposal by deep burial).

A population reduction program in susceptible feral animal populations may also need to be considered (see Section 4.3.14). Where implemented, population reduction programs must be designed to minimise dispersal of feral animal populations.

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<sup>42</sup> To be conducted by competent personnel and in conformance with the requirements for culling for management of wild/feral animals (e.g. see <https://pestsmart.org.au/toolkit-resource/aerial-shooting-of-feral-pigs/>).

## Welfare destruction

Humane destruction on-site may be considered on premises (whether IPs or not) where animals are at risk of compromised welfare (e.g. overcrowding of pigs due to the imposition of movement controls) and transport to appropriate processing facilities presents an unacceptable risk of disease transmission.

Welfare destruction must not affect the resourcing of destruction for disease control purposes. As a general approach, a prioritisation hierarchy could involve destruction of:

1. clinical animals and other animals on IPs
2. animals for urgent welfare reasons (e.g. animals that cannot obtain feed or water, animals that have compromised shelter/housing, unweaned young of clinically affected mothers)
3. high-risk nonclinical animals
4. animals for non-urgent welfare reasons.

These priorities could occur concurrently, if practicable.

Where destruction for welfare purposes is to be considered for cost sharing, see the EADRA guidance documents *Livestock welfare management and compensation principles for parties to the Emergency Animal Disease Response Agreement and Consequential loss*.<sup>43</sup>

## Pre-emptive slaughter or destruction

Pre-emptive slaughter or destruction of susceptible animals may be considered to achieve the disease control objectives.

Consideration should be given to:

- the risk if animals were to become infected with FMD virus (e.g. security of animals and ability to contain them)
- the animals' vaccination status and resulting anticipated disposition (e.g. remove or retain policy for vaccinated stock)
- the available and forecasted resources to undertake the destruction and, if necessary, disposal
- the practicality of managing animals to meet response objectives (e.g. the practicality of vaccinating feral or extensively kept cattle).

### 4.3.12 Disposal of animals, and animal products and byproducts

Disposal plans should be developed for each premises under site-specific biosecurity and movement controls (IPs, DCPs, DCPFs and ADSs), including development of an inventory of items before their disposal.

Guidance on disposal options and methods can be found in the **AUSVETPLAN Operational manual: Disposal**.

## Specific considerations

Potentially contaminated materials from high-risk premises under legislative instrument should be disposed of in a biosecure manner on-site or at an ADS.

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<sup>43</sup> [www.animalhealthaustralia.com.au/training/emergency-animal-disease-training/guidance-documents/](http://www.animalhealthaustralia.com.au/training/emergency-animal-disease-training/guidance-documents/)

These materials include carcasses, culled animals, animal products and byproducts, wastes, effluent and contaminated fomites (e.g. clothing, equipment) that cannot be adequately decontaminated. Feed, crops and so on may be high-risk materials if, based on epidemiological assessment, they are implicated in the spread of disease or are otherwise potentially contaminated with FMD virus (e.g. effluent from infected animals has been sprayed on crops).

The method chosen for disposal will be influenced by the type and volume of material to be disposed of, the resources available, the local environment, prevailing weather, legislative requirements (including environmental protection legislation) and the risk of spreading the disease. Disposal must be done in a way that prevents feral animals gaining access to contaminated material and so spreading the disease. Options for disposal of high-risk material in an FMD response include deep burial, composting and high-temperature incineration (e.g. using air curtain incinerators). Processing off-site (e.g. rendering) before disposal at an ADS may also be considered in some circumstances.

All equipment and machinery involved in on-site disposal must be decontaminated.

Where disposal on-site is not feasible, an ADS may be used, subject to risk assessment and taking into consideration the risk of FMD virus transmission during transport of the risk material to the disposal site. Movements of risk material should be in accordance with the recommended movement controls in Section 6.

Similarly, where processing off-site (e.g. rendering) is considered before disposal at an ADS, it should be subject to risk assessment, taking into consideration the risk of FMD virus transmission during transport of the risk material, the processing to be undertaken and the biosecurity measures in place at the processing facility. Movements of risk material should be in accordance with the recommended movement controls in Section 6.

## Disposal of milk

Disposal of milk will be a major challenge during an FMD outbreak involving a dairying area, because large volumes of milk may require disposal (depending on the time of year, and the location and size of the outbreak). This is because milk will not be collected for commercial processing from IPs or SPs, and may not be collected from DCPs or TPs. Instead, it will be subject to biosecure disposal. On-farm storage may be considered for SPs pending confirmation of their status if it is likely that the status will be resolved within food safety timelines and capacity is available.

To limit the volumes of milk requiring disposal, dairy animals on premises subject to destruction should be prioritised accordingly. For high-risk premises where animals are not subject to destruction, options such as drying off cows (see the **AUSVETPLAN Enterprise manual: Dairy (cattle) industry**) and using bobby calves already on the farm may be considered to reduce the amount of milk that ultimately requires disposal. On-site treatment of milk (e.g. acidification) to inactivate the virus should be considered to enable disposal on-site or off-site. Premises with on-farm milk processing facilities (e.g. small cattle, sheep or goat dairies) may be able to inactivate FMD virus on site, reducing milk volumes requiring disposal.

### 4.3.13 Decontamination

Decontamination plans should be developed for each IP and other premises to be decontaminated, based on a risk assessment. Guidance on decontamination can be found in the **AUSVETPLAN Operational manual: Decontamination**.

## Specific considerations

Decontamination of premises, animal products, equipment and other fomites (e.g. vehicles, clothing) that may be contaminated with FMD virus will be a critical part of the response. This will include decontamination of the surfaces of roads and yards adjacent to and within IPs, DCPs and DCPFs. If roadways and common surfaces are considered potentially contaminated adjacent to and within other premises, such as ADSs, they should also be decontaminated.

Contaminated materials and items that may be damaged by decontamination — or for which decontamination is not practical or readily achievable — may be destroyed and/or disposed of in a biosecure manner instead.

On premises where animal destruction is undertaken, decontamination should follow depopulation and disposal activities. At all stages, steps will be taken to prevent the generation and dispersal of infective dusts and aerosols, and to manage potentially contaminated runoff.

Agents that destroy FMD virus include sunlight (by desiccation, not by the effects of ultraviolet radiation); sodium hypochlorite; and acid and alkaline disinfectants such as sodium hydroxide, sodium carbonate (washing soda) and citric acid.

Guidance on inactivation of FMD virus is provided in Section 2.4.2, the **AUSVETPLAN Operational manual: Decontamination** and the WOAH Terrestrial Code.

### 4.3.14 Wild (including feral) animal management

General guidance on the management of wild and/or feral animals in an EAD response is provided in the **AUSVETPLAN Operational manual: Wild animal response strategy**. Wild/feral animals that are specifically relevant to FMD — including wild cloven-hoofed animals — are listed in Section 2.2.

Entry, spread and maintenance of FMD in wild/feral animal populations will be subject to ongoing risk assessment to ensure that feral animals are fully considered in the design of the eradication program. Risk mitigation programs will be implemented in feral animal populations that are assessed to pose an unacceptable risk. Assessment will require information about:

- the density and distribution of the animals
- social organisation, including home ranges
- habitat
- perceived contact with domestic species
- the strain of FMD virus
- the length of time feral animals could have been exposed to the virus
- welfare impacts on wild/feral animals (e.g. implications for the animals of the control or destruction methods used)
- the availability of resources to effectively implement control measures
- potential exposure of feral animals to risk materials, such as at landfill sites, in paddocks on which effluent or milk has been sprayed, or in areas used for composting.

Depending on the assessed risk, a number of control measures may be applied, including tracing and surveillance, containment, restrictions on hunters (also see Section 4.3.2) and population reduction.

### 4.3.15 Vector management

FMD virus has been found in rat faeces and urine, and in bird droppings (Sutmoller et al 2003). Capel-Edwards (1970) reported finding 1000 ID<sub>50</sub> per gram in rat faeces, although there has been no supporting evidence of the role of rats in the epidemiology of FMD. Similarly, Kaleta (2002) speculated that, during epizootics of FMD, the plumage of free-living birds, especially starlings, seagulls and house sparrows, may be contaminated by FMD virus and may spread the virus over long distances; however, evidence supporting this hypothesis is lacking.

Despite the possibility that some rodents (e.g. rats, mice) and birds may mechanically transmit FMD virus (Sutmoller et al 2003), the likelihood of a transmission event will be influenced by several factors. These include the number of vector animals contaminated at the source, transport and dissemination of the vector through natural or human-mediated means, and the route of inoculation (e.g. inhalation versus ingestion) with sufficient virus to infect a susceptible animal. The role of such vectors in the transmission of FMD virus is unlikely to be significant. However, vector control should still be undertaken to reduce the likelihood of mechanical virus transmission (Auty et al 2019).

Rodents likely to be dispersed from buildings, silos or other structures as a result of operational activities, particularly on IPs and DCPs, should be controlled where practical and reasonable as a precautionary measure, to limit the spread of virus to susceptible species on premises close to where FMD is confirmed or suspected.

### 4.3.16 Public information

Guidance on managing public information can be found in the ***Biosecurity incident public information manual***.

Public information, and industry and community engagement will support a cohesive response. The communications strategy should include mechanisms for raising awareness in all community sectors, including hunters, owners of petting zoos and school farms, urban and peri-urban pig owners, and managers of smaller enterprises (that may not be engaged with their industry peak body, for example).

Key topics to be covered in public information messaging will include advice on:

- the safety to people of consuming or handling food and other products derived from FMD virus–infected (and FMD-vaccinated) animals
- clinical signs of FMD in susceptible animals and how to report suspect cases (including drops in production)
- modes of transmission of FMD virus
- measures to prevent the entry of FMD virus to premises (including increasing awareness of prohibited pig feed and importance of implementing on-farm biosecurity plans)
- movement controls, including livestock standstills
- the importance to Australia of controlling the disease and the rationale for the measures being used
- management of animal welfare during an outbreak
- management of feral animals during an outbreak, including surveillance for proof of freedom
- the role of vaccine in disease control and management of vaccinated animals
- the role of surveillance, including proof-of-freedom surveillance, in regaining market access
- human health and financial support mechanisms available
- where to find more information on the response and the control measures being used.

National coordination of public information and engagement messaging in the event of an FMD incident in Australia may occur through activation of the National Biosecurity Communication and Engagement Network<sup>44</sup> to coordinate animal health information, and liaise with public health and environmental agencies.

#### 4.3.17 Other strategies

Feeding prohibited pig feed to pigs carries a high risk of introducing FMD to a herd. There is also a high risk associated with feeding other susceptible species milk; milk products; waste, surplus and out-of-date retail milk; and washings from processing plants. A multi-agency approach will be needed to enforce current bans on feeding prohibited pig feed and swiftly introduce legislation, if not already in place, to ban feeding of dairy products to pigs and other FMD-susceptible species (unless the products have been treated as described in Section 2.4.2, the **AUSVETPLAN Operational manual: Decontamination** and the WOAHA Terrestrial Code, or are to be fed to the offspring of dairy animals resident on the same farm). Security at municipal waste management centres, including waste transfer stations, should be implemented to prevent feral pigs gaining access to domestic food scraps. A widespread, multilingual public information campaign should support these controls. The campaign may also include messaging about risks posed by other refuse pits (e.g. on-farm).

#### 4.3.18 Stand-down

Guidance on the stand-down of EAD responses can be found in the **AUSVETPLAN Management manual: Control centres management (Part 1)**.

The CCEAD will determine when the outbreak has been controlled or eradicated and will advise the NMG. The NMG will determine when the national FMD control measures can be wound down or ceased, and each jurisdiction will advise its ministers of this decision. Relief and recovery activity will need to continue after disease control and eradication operations have wound down.

Additional information on the national coordination framework for responding to an outbreak of FMD is provided in the Council of Australia Governments *Memorandum of understanding: national response to a foot-and-mouth disease (FMD) outbreak*.<sup>45</sup>

### 4.4 Other control and eradication options

If destruction, disposal and decontamination, with or without vaccination, are not able to eradicate the disease, FMD could become established in Australia. The measures to underpin the long-term control of FMD in such circumstances will be determined following consultation between governments and livestock industries. They may include long-term vaccination programs, zoning and/or compartmentalisation, and transition to management under the EADRA.

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<sup>44</sup> [www.outbreak.gov.au/about/biosecurity-incident-national-communication-network](http://www.outbreak.gov.au/about/biosecurity-incident-national-communication-network)

<sup>45</sup> <https://federation.gov.au/about/agreements/memorandum-understanding-national-response-foot-and-mouth-disease-fmd-outbreak>

## 4.5 Funding and compensation

Details of the cost-sharing arrangements can be found in the EADRA.<sup>46</sup> Details of the approach to the valuation of, and compensation for, livestock and property in disease responses can be found in the **AUSVETPLAN Operational manual: *Valuation and compensation***.

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<sup>46</sup> <https://animalhealthaustralia.com.au/eadra/>

## 5 Declared areas and premises

When an emergency animal disease (EAD) is first suspected, the premises involved will undergo a clinical and/or epidemiological investigation. If the case definition, as defined in the relevant AUSVETPLAN response strategy, is met (i.e. the index case), the relevant chief veterinary officer or their delegate will determine the premises classification and will declare the premises an infected premises (IP).

### 5.1 Declared area definitions

Declared areas are declared under jurisdictional biosecurity legislation to enable specified activities that are required, restricted or prohibited in order to contain, control and/or eradicate an EAD.

Declared areas comprise:

- restricted areas (RAs), which are subject to strict disease control measures
- control areas (CAs), which are disease-free buffers between an RA and the parts of Australia that are free from the EAD (the outside area (OA)).

Detailed guidelines for declared areas are provided in the **AUSVETPLAN Guidance document: *Declared areas and allocation of premises definitions in an emergency animal disease response***.

#### 5.1.1 Restricted area (RA)

The RA is a legally declared area that is subject to disease controls, including intense surveillance and movement controls.

In the case of foot-and-mouth disease (FMD), an initial RA of at least a 3 km radius will be drawn around all IPs and dangerous contact premises (DCPs), including as many suspect premises (SPs) and trace premises (TPs) as practicable. The boundaries will be modified based on risk assessment as new information comes to hand. The actual distance in any one direction will be determined by factors such as terrain, roads, the pattern of livestock movements, livestock concentrations, the weather (including prevailing winds), the distribution and movements of susceptible feral animals, and known characteristics of the virus serotype. A high level of movement control and surveillance will apply. Where FMD-susceptible feral animals are involved, it will also encompass the infected area (IA).

#### 5.1.2 Control area (CA)

For FMD, the CA may initially encompass the whole of the affected state(s) or territory(i.e.s). The size of the CA will be reassessed through the duration of the response, as the situation evolves. The CA will have a minimum radius of 10 km, encompassing the RA. It may be defined according to geography, climate and the distribution of feral animals. The boundary will be adjusted as confidence about the extent of the outbreak increases.

Where only feral susceptible species are thought to be infected, the CA may be informed by consideration of the maximum ranging distance around the confirmed case.

## 5.2 Other areas

Other areas may be declared under jurisdictional legislation and may be referenced in AUSVETPLAN. These areas may be nested within, or overlie part or all of, other areas (declared or not). They include the OA (see below).

### 5.2.1 Outside area (OA)

The OA is not a declared area but is used to describe the rest of Australia outside the declared areas. The OA will be subject to surveillance. Because it is highly desirable to maintain the OA as 'disease-free', the movement of animals and commodities from the RA and the CA into the OA will be restricted.

The OA will also be of interest for zoning<sup>47</sup> and compartmentalisation<sup>48</sup> for purposes of trade access, as well as for disease control (see below).

## 5.3 Premises classifications

Detailed guidelines for classifying premises statuses are provided in the **AUSVETPLAN Guidance document: *Declared areas and allocation of premises definitions in an emergency animal disease response***. Definitions of premises are in the Glossary.

### 5.3.1 Premises status classifications

For FMD, the premises classifications to be used are:

- infected premises (IP)
- suspect premises (SP)
- trace premises (TP)
- dangerous contact premises (DCP)
- dangerous contact processing facility (DCPF)
- approved processing facility (APF)
- approved disposal site (ADS)
- at-risk premises (ARP)
- premises of relevance (POR)
- resolved premises (RP)
- unknown status premises (UP)
- zero susceptible species premises (ZP)
- infected area (IA).

For feral susceptible species, there is no infected premises classification. Rather, the IA represents the area thought to be contaminated with FMD virus and would most closely equate to an IP.

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<sup>47</sup> The process of defining, implementing and maintaining disease-free and infected areas, in accordance with World Organisation for Animal Health (WOAH) standards. Zoning is based on geopolitical and/or physical boundaries and surveillance, to facilitate disease control and/or trade.

<sup>48</sup> The process of defining, implementing and maintaining one or more disease-free establishments, under a common biosecurity management system, in accordance with WOAH standards. Compartmentalisation is based on applied biosecurity measures and surveillance, to facilitate disease control and/or trade.

## 5.3.2 Qualifiers

Refer to the **AUSVETPLAN Guidance document: *Declared areas and allocation of premises definitions in an emergency animal disease response*** for more detail on qualifiers.

### Assessed negative (AN)

AN is a qualifier that may be applied to ARPs, PORs, SPs, TPs, DCPs or DCPFs. The qualifier may be applied following surveillance, epidemiological investigation and/or laboratory assessment/diagnostic testing and indicates that the premises is assessed as negative at the time of classification. SPs, TPs, DCPs or DCPFs, once assessed negative, can progress through the SP-AN, TP-AN, DCP-AN or DCPF-AN status to another status. The animals on such premises are subject to the procedures and movement restrictions appropriate to the declared area (IA, RA or CA) in which the premises is located.

This classification is a description to document progress in the response and in the proof-of-freedom phase. The AN qualifier is a temporary status and only valid at the time it is applied. The time for which the AN qualifier remains active will depend on the circumstances and will be decided by the jurisdiction. One day is considered a reasonable guideline. The AN qualifier should also provide a trigger for future surveillance activity to regularly review, and change or confirm, a premises status.

The AN qualifier can also function as a counting tool to provide quantitative evidence of progress, to inform situation reports in control centres during a response. It provides a monitor for very high priority premises (SPs and TPs) as they undergo investigations and risk assessment, and are reclassified, as well as a measure of surveillance activity overall for ARPs and PORs.

The AN qualifier can be applied in a number of ways, depending on the objectives and processes within control centres. The history of each premises throughout the response is held in the information system; the application of the AN qualifier is determined by the jurisdiction, the response needs and the specific processes to be followed in a state coordination centre or local control centre.

### Sentinels on site (SN)

SN is a qualifier that may be applied to IPs and DCPs to indicate that sentinel animals are present on a premises as part of response activities (i.e. before the premises can be assessed as an RP).

The qualifier should not be applied to premises that have been resolved and have been allowed to restock (regardless of the stocking density chosen for initial restocking).

### Vaccinated (VN)

The VN qualifier can be applied in a number of different ways. At its most basic level, it can be used to identify premises that contain susceptible animals that have been vaccinated against the EAD in question. However, depending on the legislation, objectives and processes within a jurisdiction, the VN qualifier may be used to track a range of criteria and parameters. The details would need to be developed and tailored to meet individual needs of jurisdictions and circumstances.

## 5.3.3 Other disease-specific classifications

Not relevant.

## 5.4 Reclassifying premises and previously declared areas

Maintaining movement restrictions on areas for long periods has important implications for resource management, animal welfare, business continuity, and socioeconomic impacts on producers and regional communities. Therefore, attention should be given to reclassifying premises and previously declared areas as quickly as possible.

Detailed guidelines for reclassifying previously declared areas are provided in the **AUSVETPLAN Guidance document: *Declared areas and allocation of premises definitions in an emergency animal disease response***.

### 5.4.1 Reclassifying premises

Guidelines for assessing SPs and TPs as negative and reclassifying their status are outlined in Section 7.1.2.

IAs, IPs and DCPs require action to address the risk that infection or contamination with FMD virus is present. To assess an IA, IP, DCP or DCPF as negative — and allow its reclassification, release from biosecurity controls and, if appropriate, restocking — consideration must be given to the effectiveness of decontamination (through natural, physical and/or chemical means) in eliminating virus and, where appropriate, placement of sentinel animals.

The actual time before placement of sentinel animals should consider a range of factors, including:

- the presence and close proximity of disease
- factors affecting virus viability and infectivity (e.g. substrate protein or lipid content, ambient temperature, water content, virus virulence, amount of virus)
- confidence in decontamination through natural, physical and/or chemical means
- the status of the disease response within the declared area.

Guidance on the use of sentinel animals, where appropriate, before a premises is released from biosecurity controls and restocked is provided in Section 7.1.3.

## 6 Movement controls

### 6.1 Guidelines for issuing permits

In an emergency animal disease (EAD) event, quarantine and movement controls must strike a balance between quick and effective disease control, business continuity and animal welfare. Although it might not be feasible to prohibit all movement of susceptible animals and products, diligence needs to be applied to minimise the risk of further spread of the disease.

Recommended quarantine and movement controls in each AUSVETPLAN response strategy provide guidance on which movements can be allowed and under what conditions. This is based on an analysis of the disease risks that are presented by a specific movement, of a specific commodity, at a specific time during the EAD response phase. Each disease strategy will indicate whether a proposed movement is:

- allowed (under normal jurisdictional, including interstate, requirements)
- prohibited — except under the conditions of a general, special or emergency permit
- prohibited.

Permits may not be available until the relevant chief veterinary officer (CVO) provides approval for movements, and this may not be available in the early stages of a response. When assessing risk for the purposes of issuing a permit, the elements to consider may include:

- sources of risk
  - species of animal
  - type of product
  - presence of disease agent on both the originating and destination premises
  - current vector activity, if relevant
  - organisation and management issues (i.e. confidence in animal tracing and surveillance, biosecurity)
  - proposed use of the animals or products
  - proposed transport route
  - vaccination status of the animals, if relevant
  - treatment of animals and vehicles to prevent concurrent movement of vectors, if relevant
  - security of transport
  - security and monitoring at the destination
  - environment and natural events
  - community and human behaviour
  - risk of sabotage
  - technology
  - regulations and standards
  - available resources for compliance and enforcement
- areas of impact:
  - livestock health (health of affected species, including animal welfare)
  - human health (including work health and safety)
  - trade and economic impacts (including commercial and legal impacts)
  - environmental impacts
  - organisational capacity

- political impacts
- reputation and image
- proposed risk treatment measures
  - vaccination
  - processing of product
  - disinfection or other treatment of animals, vehicles and fomites
  - vector control, if relevant
  - security
  - communication.

Movements that are otherwise prohibited may be considered on a case-by-case basis (informed by risk assessment) for emergency (including welfare) reasons. Examples are movements for emergency veterinary treatment and movements to different premises to manage welfare concerns (e.g. feed, space, milking availability).

If allowed, such movements will be under approval from the relevant CVO or delegate (emergency permit) after assessment indicates that the risk associated with the movement is acceptable within the response.

## 6.2 Types of permits

Permits are either general or special. They are legal documents that describe the animal(s), commodities or things to be moved, the origin and destination, and the conditions to be met for the movement. Either type of permit may include conditions. Once permit conditions have been agreed from an operational perspective, all permit conditions must be met for every permit. Both general and special permits may be in addition to documents required for routine movements between or within jurisdictions (e.g. health certificates, waybills, consignment notes, National Vendor Declarations — NVDs).

### General permit

General permits (GPs) are used for lower risk movements, and create a record of each movement to which they apply. They are granted without the need for direct interaction between the person moving the animal(s), commodity or thing and a government veterinarian or gazetted inspector of stock. The permit may be completed via a webpage or in an approved place (such as a government office or commercial premises). A printed or electronic version of the permit must accompany the movement. The permit may impose preconditions and/or restrictions on movements. GPs may not be available until the relevant CVO gives approval for general movements, and this may not be available in the early stages of a response.

### Special permit

Special permits (SpPs) are issued by the relevant government veterinarian or gazetted inspector of stock. They are used for higher-risk movements, and therefore require formal application and individual risk assessment. SpPs describe the requirements for movement of an animal (or group of animals), commodity or thing, for which a specific assessment has been conducted by the relevant government veterinarian or gazetted inspector of stock. A printed or electronic version of the permit must accompany the movement. The permit may impose preconditions and/or restrictions on movements.

### Emergency permit

An emergency permit is an SpP that specifies strict legal requirements for an otherwise high-risk movement of an animal, to enable emergency veterinary treatment to be delivered, to enable animals to be moved for

animal welfare reasons, or to enable any other emergency movement under exceptional circumstances. These permits are issued on a case-by-case basis under the authorisation of the relevant CVO.

### **Other movement requests**

Movements not reflected within any of the movement control matrixes or narratives may be considered by the relevant jurisdictional CVO on a risk-assessed case-by-case basis.

## **6.3 Recommended movement controls**

General principles for quarantine practices and movement controls for managing EADs are provided in the **AUSVETPLAN Guidance document: *Movement controls***.

Key considerations for quarantine practices and movement controls for managing foot-and-mouth disease (FMD) are as follows:

- Containment and eradication of FMD is the highest priority. Therefore, 'normal business movements' should not be expected.
- Live animals pose the greatest risk of disease spread; therefore, their movements from all premises within the restricted area (RA) and control area (CA) must be strictly controlled.
- The outside area (OA) should remain as 'clean' as possible. Therefore, movement of animals from the RA to the OA is prohibited, and movement of products is generally prohibited. Movement of animals and products from the CA to the OA will also be restricted.
- Trace premises (TP) and suspect premises (SP) are temporary classifications, and every effort should be made to resolve the status of these premises as soon as possible.
- The numbers of susceptible animals within the RA should be minimised. Therefore, movements of animals into the RA will be limited and usually for slaughter only.
- Movement restrictions are more stringent within the RA than within the CA and will be more stringent in the early stages of the response.
- Movement controls during a response may differ from those listed here. However, this will involve a variation to the Emergency Animal Disease Response Plan, with endorsement by the Consultative Committee on Emergency Animal Diseases (CCEAD) and the National Management Group (NMG).
- Recommended movement controls apply to any movement to and from a premises, whether on foot or by vehicle, that involves either public or private land.
- All movement control matrixes and narratives are for guidance.
- Application for a movement permit does not automatically mean that one will be granted.
- In emergency or exceptional circumstances, any proposed movement may be considered by the jurisdictional CVO on a risk-assessed case-by-case basis.
- Interstate movements will need to meet the import requirements of the receiving jurisdiction.

A 3-stage<sup>49</sup> approach to movement controls will be implemented during an outbreak of FMD.

### **Stage 1: Movement controls while the national livestock standstill is in effect**

Movement controls will apply to:

- FMD-susceptible livestock in transit at the time of declaration of the national livestock standstill
- proposed new movements of FMD-susceptible livestock while the national livestock standstill is in effect.

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<sup>49</sup> The 3 stages may overlap or occur asynchronously between jurisdictions.

Individual jurisdictions may impose additional movement restrictions based on assessment of risk.

When a national livestock standstill is in place, essential husbandry movements for dairy cattle that involve crossing public roads — such as moving the milking herd to the milking shed — may continue unless advised otherwise, provided that the farmer had prior appropriate approval from the state road authority or local council. The cows must be managed to minimise faecal contamination of the road (e.g. hold mob for a period before crossing) and be walked directly across the road. Cows may be walked within the farm premises for milking.

**Stage 2: Movement controls immediately after declared areas (RAs and CAs) have been established by jurisdictions<sup>50</sup>**

**Stage 3: Movement controls when declared areas remain in effect, and the CCEAD and the NMG consider it appropriate to reduce movement restrictions<sup>51</sup>**

### 6.3.1 Live susceptible animals

**Stage 1: Recommended movement controls for FMD-susceptible livestock while the national livestock standstill is in effect**

**FMD-susceptible livestock in transit at the time of declaration of the national livestock standstill**

*Definition of FMD-susceptible livestock in transit*

FMD susceptible livestock ‘in transit’ are livestock that are loaded in a livestock transport vehicle (e.g. truck/trailer; rail car) or under their own motion (e.g. on a stock route) and which are moving in a place other than the place of origin (e.g. private or public road, stock route, rail or domestic air or sea space). Animals that reach their destination are no longer in transit and can be unloaded.

‘In transit’ also includes:

- cross-loading<sup>52</sup>, provided the risk of FMD virus spread is not increased
- cases when livestock transport vehicles have stopped for reasons as follows:
  - mandatory breaks for transporters (depending on legal requirements)
  - meeting the needs and requirements for animal and transporter (e.g. driver) welfare
    - toilet and bathroom breaks
    - transporter food and drink breaks
    - undertake welfare checks on the livestock
    - basic fatigue and advanced fatigue management
    - wetting down of animals in hot weather
  - breakdown (e.g. mechanical breakdown; flat tyre)
  - road, rail or route accidents, closures or delays
  - management of effluent
  - refuelling

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<sup>50</sup> For further information, refer to Section 5.1.

<sup>51</sup> This would occur when the situation was more under control and few, if any, new IPs were being detected.

<sup>52</sup> Cross-loading involves reversing two trucks together, with the drivers assisting to move livestock from one trailer to the next. Livestock may or may not be unloaded onto the ground to facilitate cross-loading. Where animals are unloaded onto the ground, it must be purely to facilitate the transfer — not for spelling, feeding or watering animals.

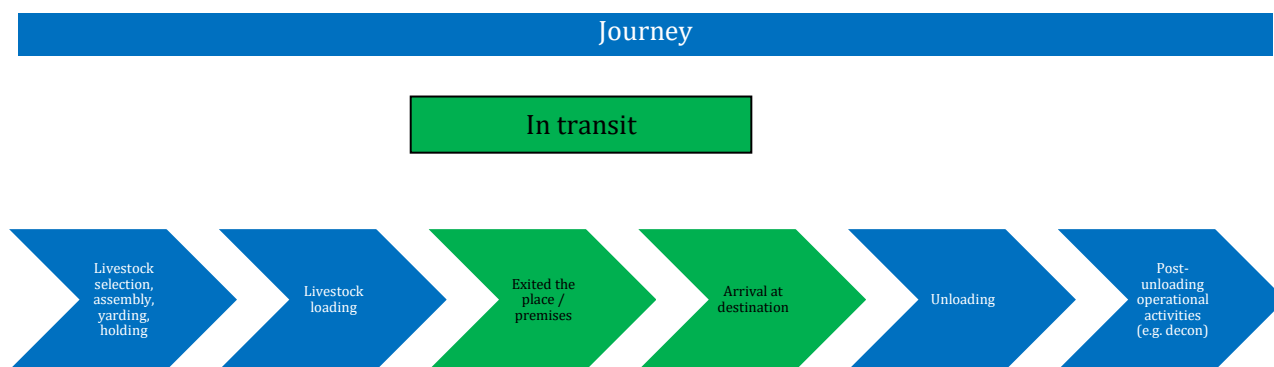
- waiting to access sites (e.g. processors).

‘In transit’ does not include other parts of the ‘journey’. It does not include:

- livestock selection, assembly, yarding and holding, or loading livestock on the premises or place of origin
- where the livestock transport vehicle has loaded (partially or completely) but has not left the property / premises / place, noting:
  - for premises where loading has commenced, but where premises conditions (e.g. loading facilities or biosecurity practices) preclude unloading of livestock back onto the premises, a case-by-case assessment will be undertaken by the jurisdiction in collaboration with the livestock owner and transporter
- spelling livestock. Once livestock are unloaded for spelling, they must not be moved from the premises/place unless under government authorisation.

Figure 6.1 provides a simplified overview of the ‘in transit’ definition.

**Figure 6.1 Overview of ‘in transit’ definition**



### *Overview of the management of FMD-susceptible livestock in transit*

Unless advised otherwise, FMD-susceptible livestock in transit at the time a national livestock standstill is declared may return to the property of origin or continue to the intended destination in accordance with the principles outlined below.<sup>53</sup>

These principles should be used to determine the movement of susceptible livestock — whether to return to the property of origin or continue to the intended destination. If the risk of disease spread is lower if the journey continues to the intended destination than if the livestock return to the property of origin, the livestock should continue to the intended destination. These principles are subject to the destination, either intended or diverted, accepting the livestock.

The following principles have been developed by taking into account factors including the spread of FMD virus, the nature of the movements, including supply chain factors, livestock and driver welfare, and the feasibility of any movement controls. These factors are intended to guide stakeholders in risk-based decision making.

When these principles cannot be actioned, the relevant jurisdictional government should be contacted.

<sup>53</sup> These principles may be superseded by specific jurisdictional CA or RA control measures that may be implemented simultaneously or shortly after the declaration of a national livestock standstill. Reference to ‘livestock’ implies ‘FMD-susceptible livestock’.

## *Principles for the management of FMD-susceptible livestock in transit*<sup>54</sup>

1. Livestock must not cross jurisdictional borders without a permit from the receiving jurisdictional government authorities.
2. Livestock on stock routes should proceed to the nearest location on the route that meets animal welfare needs during the livestock standstill.
3. Livestock should continue to the intended destination premises in the following situations:
  - the intended destination premises is an abattoir
  - where returning to the premises of origin would compromise driver health and safety, transport regulatory compliance or animal welfare in transit.
4. If the vehicle is carrying livestock from multiple premises of origin and the intended destination is:
  - an aggregation point<sup>54</sup>, the livestock may return to the most recent pickup premises; however, if that is not possible, livestock should proceed to the aggregation point
  - a single premises that is not an aggregation point, feedlot or export depot, the livestock should proceed to their intended destination
  - multiple premises, the livestock may be unloaded at either the most recent pickup premises or the next intended destination premises
  - an export depot or ruminant feedlot then, based on jurisdictional advice, the livestock may continue to the intended destination OR return to the most recent pickup premises OR continue to an alternate destination.
5. Livestock should return to the premises of origin in the following situations:
  - the vehicle is carrying livestock sourced from one premises with the intent of delivering consignments to multiple premises (unless all the livestock are unloaded only at the next intended destination premises)
  - the transport vehicle is carrying livestock from a single premises of origin and the intended destination premises is an aggregation point, export depot or ruminant feedlot
  - the journey commenced from an aggregation point and the intended destination premises is not an abattoir.
6. If the vehicle is carrying livestock from a single premises of origin that is not an aggregation point, to a single intended destination premises that is also not an aggregation point, export depot or ruminant feedlot, the vehicle may continue to the intended destination premises or return to the premises of origin.
7. If returning to a premises of origin or continuing to an intended destination premises in accordance with the principles above is not possible, a case-by-case assessment will be undertaken by the jurisdiction in collaboration with the livestock owner and transporter.

Potential alternatives may include:

- redirect to an alternate location under the advice of jurisdictional authorities

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<sup>54</sup> In the context of a national livestock standstill, aggregation points include locations where livestock from multiple source premises would usually be aggregated temporarily before onward movement. This includes, but is not limited to, saleyards, showgrounds, livestock transfer facilities, spelling yards and scales operations. It excludes ruminant feedlots, export depots, and locations where livestock may be aggregated for destruction or slaughtering (e.g. abattoirs).

- redirect to an abattoir under the advice of jurisdictional authorities and with prior approval of the processor.
8. Irrespective of the decision, upon conclusion of the journey significant biosecurity measures must be applied to minimise the likelihood of disease spread. For livestock, these should include isolation of moved livestock, surveillance and monitoring for clinical signs, and immediate recording of the movement on the National Livestock Identification System (NLIS) database. For fomites, this should include decontamination of personnel, vehicles and equipment involved in the movement of livestock in transit at the time the national livestock standstill is declared.

*Proposed new movements of FMD-susceptible livestock while the national livestock standstill is in effect*

While a national livestock standstill remains in effect, new movements of FMD-susceptible livestock are prohibited except under an emergency permit. A permit will be issued only in exceptional circumstances. Before an emergency permit is issued, a risk assessment must be completed by the relevant jurisdiction. The assessment must examine both the likelihood that FMD-susceptible animals may be infected (including incubating animals) and the consequences of the movement should infected animals be moved.

Emergency permit conditions for the movement of FMD-susceptible animals during the standstill will include:

- absence of links to any premises that are infected premises (IPs), dangerous contact premises (DCPs), dangerous contact processing facilities (DCPFs), TPs or SPs
- a defined route of travel that minimises any potential for disease spread
- assurance that biosecurity standards at the despatching and receiving premises are appropriate
- that there is a single consignment per load
- appropriate decontamination of personnel, equipment and vehicles before and after movement
- absence of clinical signs of FMD in all susceptible animals on the source and destination premises before and on the day of travel
- physical identification of animals (e.g. NLIS) or other ear tag, brand, tattoo, earmark) with accompanying documentation (e.g. NVD, waybill, PigPass, Livestock Health Statements).

**Stage 2: Recommended movement controls for FMD-susceptible livestock immediately after declared areas have been established by jurisdictions**

The transition to stage 2 may overlap with stages 1 and 3, and may occur at different times in different jurisdictions, because processes to implement and revoke the livestock standstill declaration may differ.

Because of the high potential of transmitting FMD virus, movement of FMD-susceptible livestock from high-risk premises and the RA is generally prohibited. Movement of FMD-susceptible livestock into an RA should be minimised, and usually only for slaughter, to limit the number of additional susceptible animals within the RA.

Table 6.1 describes the recommended movement controls for FMD-susceptible livestock within and between declared areas at the commencement of stage 2. The only allowed movements of FMD-susceptible livestock in the RA would be either to slaughter at an approved processing facility (APF) or, following a risk assessment, to an at-risk premises (ARP) or TP, primarily for welfare reasons.

As the outbreak stabilises in response to control measures, some movement restrictions may gradually be reduced based on risk assessment, and as the CCEAD and NMG deem appropriate to the situation (see stage 3).

**Table 6.1 Recommended movement controls for FMD-susceptible livestock during stage 2**

To From		RA		CA		OA
		IP / DCP / SP / TP	ARP / APF <sup>a</sup>	SP / TP	POR / APF <sup>a</sup>	
RA	IP, DCP, SP,	Prohibited		Prohibited		Prohibited
	TP	Prohibited				
	ARP	Prohibited	Prohibited, except under SpP1			
CA	SP	Prohibited		Prohibited		Prohibited
	TP	Prohibited		Prohibited		
	POR	Prohibited	Prohibited, except under SpP2	Prohibited	Prohibited, except under SpP3	
OA	OA	Prohibited	Prohibited, except under SpP2	Prohibited	Prohibited, except under SpP3	Allowed under normal jurisdictional requirements

APF = approved processing facility; ARP = at-risk premises; CA = control area; DCP = dangerous contact premises; IP = infected premises; OA = outside area; POR = premises of relevance; RA = restricted area; SP = suspect premises; SpP = special permit; TP = trace premises

<sup>a</sup> Meat derived from animals moved from low-risk premises would be considered low risk and is covered by Table 6.4 (Recommended movement controls for meat and meat products (including carcasses and offal) of FMD-susceptible animals from registered commercial abattoirs and commercial meat processing enterprises).

**SpP1 conditions — emergency permit for exceptional circumstances only (i.e. primarily for welfare reasons):**

- With CVO approval, for slaughter, or to an ARP for other purposes (e.g. health and welfare reasons — feed, water, milking, prevention of overcrowding), if a risk assessment indicates that the risk associated with movement is acceptable within the response.
- Travel by specified route only, and no stopping en route.
- Appropriate biosecurity standard at receiving premises.
- Appropriate decontamination of equipment and vehicles, before and after movement.
- An effluent management plan is in place for the vehicle.<sup>55</sup>
- Absence of clinical signs of FMD in all susceptible animals on the premises before and on day of travel.
- Single consignment per load.

<sup>55</sup> There is an appropriate curfew for stock (i.e. holding them off feed for a certain period) before being transported, an effluent containment tank is in place on the vehicle, and a plan is in place for disposal of effluent. Curfew times can be found in the Australian Animal Welfare Standards and Guidelines ([www.agriculture.gov.au/agriculture-land/animal/welfare/standards-guidelines](http://www.agriculture.gov.au/agriculture-land/animal/welfare/standards-guidelines)).

- Any suspect clinical signs are immediately reported to the local control centre (LCC) or state coordination centre (SCC).
- Physical identification of animals (e.g. NLIS or other ear tag, brand, tattoo, earmark), with appropriate accompanying movement documentation (e.g. NVD, waybill, PigPass, Livestock Health Statements).

**SpP2 conditions — for slaughter only, if the RA contains the only available abattoir:**

- For slaughter only, if a risk assessment indicates that the risk associated with the movement is acceptable within the response.
- Travel by specified route only, and no stopping en route.
- Appropriate biosecurity standard at receiving premises.
- Appropriate decontamination of equipment and vehicles, before and after movement.
- An effluent management plan is in place for the vehicle.<sup>57</sup>
- Absence of clinical signs of FMD in all susceptible animals on the premises before and on day of travel.
- Single consignment per load.
- Any suspect clinical signs are immediately reported to the LCC or SCC.
- Physical identification of animals (e.g. NLIS or other ear tag, brand, tattoo, earmark), with accompanying movement documentation (e.g. NVD, waybill, PigPass, Livestock Health Statements).

**SpP3 conditions — for slaughter, or to a premises of relevance (POR) for other purposes (e.g. health and welfare reasons — feed, water, milking):**

- For slaughter, or to a POR for a specific purpose (e.g. health and welfare reasons — feed, water, milking, prevention of overcrowding), if a risk assessment indicates that the risk associated with movement is acceptable within the response. For the purposes of this permit, the definition of POR includes APFs (i.e. an abattoir or knackery or other such plant to which animals have been introduced from lower-risk premises under a permit for processing to an approved standard).
- Travel by specified route only, and no stopping en route.
- Appropriate biosecurity standard at receiving premises.
- Appropriate decontamination of equipment and vehicles, before and after movement.
- An effluent management plan is in place for the vehicle.<sup>56</sup>
- Absence of clinical signs of FMD in all susceptible animals on the premises before and on day of travel.
- Single consignment per load.
- Any suspect clinical signs are immediately reported to the LCC or SCC.
- Physical identification of animals (e.g. NLIS or other ear tag, brand, tattoo, earmark), with appropriate accompanying movement documentation (e.g. NVD, waybill, PigPass, Livestock Health Statements).

**Stage 3: Recommended movement controls for FMD-susceptible livestock when declared areas remain in effect, and the CCEAD and NMG consider it appropriate to reduce movement restrictions**

Table 6.2 describes the recommended movement controls for FMD-susceptible livestock within and between declared areas when declared areas remain in effect, and the CCEAD and NMG consider it appropriate to reduce movement restrictions. All movements of FMD-susceptible livestock to destinations out of the RA are prohibited.

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<sup>56</sup> There is an appropriate curfew for stock (i.e. holding them off feed for a certain period) before being transported, an effluent containment tank is in place on the vehicle, and a plan is in place for disposal of effluent.

**Table 6.2 Recommended movement controls for FMD-susceptible livestock during stage 3**

To From		RA		CA		OA
		IP/DCP/SP/TP/ RP	ARP/APF <sup>a</sup>	SP/TP	POR/APF <sup>a</sup>	
RA	IP, DCP, SP	Prohibited		Prohibited		Prohibited
	TP	Prohibited				
	ARP	Prohibited	Prohibited, except under SpP1			
CA	SP	Prohibited		Prohibited		Prohibited
	TP	Prohibited		Prohibited		
	POR	Prohibited	Prohibited, except under SpP2	Prohibited	Prohibited, except under GP <sub>a</sub>	
OA	OA	Prohibited, except under SpP4	Prohibited, except under SpP2	Prohibited	Prohibited, except under GP <sub>b</sub>	Allowed under normal jurisdictional requirements

APF = approved processing facility; ARP = at-risk premises; CA = control area; DCP = dangerous contact premises; GP = general permit; IP = infected premises; OA = outside area; POR = premises of relevance; RA = restricted area; RP = resolved premises; SP = suspect premises; SpP = special permit; TP = trace premises

a Meat derived from animals moved from low-risk premises would be considered low risk and is covered by Table 6.4 (Recommended movement controls for meat and meat products (including carcasses and offal) of FMD-susceptible animals from registered commercial abattoirs and commercial meat processing enterprises).

**SpP1 conditions — emergency permit for exceptional circumstances only (i.e. primarily for welfare reasons):**

- With CVO approval, for slaughter, or to an ARP for other purposes (e.g. health and welfare reasons — feed, water, milking, prevention of overcrowding), if a risk assessment indicates that the risk associated with movement is acceptable within the response.
- Travel by approved route only, and no stopping en route.
- Appropriate biosecurity standard at receiving premises.
- Appropriate decontamination of equipment and vehicles, before and after movement.

- An effluent management plan is in place for the vehicle.<sup>57</sup>
- Absence of clinical signs of FMD in all susceptible animals on the premises before and on day of travel.
- Single consignment per load.
- Any suspect clinical signs are immediately reported to the LCC or SCC.
- Physical identification of individual animals (e.g. NLIS or other ear tag, brand, tattoo, earmark), with accompanying movement documentation (e.g. NVD, waybill, PigPass, Livestock Health Statements).

**SpP2 conditions — for slaughter only, if the RA contains the only available abattoir:**

- For slaughter only, if a risk assessment indicates that the risk associated with the movement is acceptable within the response.
- Travel by approved route only, and no stopping en route.
- Appropriate biosecurity standard at receiving premises.
- Appropriate decontamination of equipment and vehicles, before and after movement.
- An effluent management plan is in place for the vehicle.<sup>58</sup>
- Absence of clinical signs of FMD in all susceptible animals on the premises before and on day of travel.
- Single consignment per load.
- Any suspect clinical signs are immediately reported to the LCC or SCC.
- Physical identification of animals (e.g. NLIS or other ear tag, brand, tattoo, earmark), with accompanying movement documentation (e.g. NVD, waybill, PigPass, Livestock Health Statements).

**SpP4 conditions — to enable sentinel stock to be introduced:**

- With CVO approval, for introduction of sentinel stock.
- Travel by approved route only, and no stopping en route.
- Appropriate decontamination of equipment and vehicles, before and after movement.
- Single consignment per load.
- Physical identification of animals (e.g. NLIS or other ear tag, brand, tattoo, earmark), with accompanying movement documentation (e.g. NVD, waybill, PigPass, Livestock Health Statements).

**GPa conditions:**

- Travel by approved route only.
- Appropriate decontamination<sup>59</sup> of equipment and vehicles, before and after movement.
- An effluent management plan is in place for the vehicle.<sup>60</sup>
- Absence of clinical signs of FMD in all susceptible animals on the premises before and on day of travel.
- Physical identification of animals (e.g. NLIS or other ear tag, brand, tattoo, earmark), with accompanying movement documentation (e.g. NVD, waybill, PigPass, Livestock Health Statements).

**GPb conditions — for slaughter or for movements within an enterprise, such as movement of offspring from a breeding herd to a grow-out unit; not for milking:**

- One-way movement only.
- Travel by approved route only.
- Appropriate decontamination<sup>61</sup> of equipment and vehicles, before and after movement.

<sup>57</sup> There is an appropriate curfew for stock before being transported, an effluent containment tank is in place on the vehicle, and a plan is in place for disposal of effluent.

<sup>58</sup> There is an appropriate curfew for stock before being transported, an effluent containment tank is in place on the vehicle, and a plan is in place for disposal of effluent.

<sup>59</sup> Refer to the **AUSVETPLAN Operational manual: Decontamination** for more information on decontamination procedures.

<sup>60</sup> There is an appropriate curfew for stock before being transported, an effluent containment tank is in place on the vehicle, and a plan is in place for disposal of effluent.

<sup>61</sup> Refer to the **AUSVETPLAN Operational manual: Decontamination** for more information on decontamination procedures.

- An effluent management plan is in place for the vehicle.<sup>62</sup>
- Absence of clinical signs of FMD in all susceptible animals on the premises before and on day of travel.
- Physical identification of animals (e.g. NLIS or other ear tag, brand, tattoo, earmark), with accompanying movement documentation (e.g. NVD, waybill, PigPass, Livestock Health Statements).

### 6.3.2 Carcasses, such as destroyed stock, mortalities or condemned stock

There may be circumstances under which carcasses of animals culled for disease control purposes cannot be disposed of on-site and need to be transported either within the RA or to a more suitable disposal site outside the RA. Movements of such carcasses should be in accordance with the nationally agreed standard operating procedures *Loading and unloading of carcasses and materials for biosecure transport* (version 1.1)<sup>63</sup> and *Biosecure movement of infected carcasses and materials during road transport* (version 1.0).<sup>64</sup> These situations should be considered on a case-by-case basis, and the movement permit should include the following conditions:

- Carcasses for disposal are transported to a declared zero susceptible species premises (ZP) or disposal site in a biosecure manner (i.e. in a manner that prevents leakage of materials from the transport vehicle).
- Transport is by an approved route.
- Carcasses are not brought into direct or indirect contact with susceptible species.
- After transportation, vehicles and equipment are decontaminated appropriately and in accordance with the **AUSVETPLAN Operational manual: Decontamination**.

### 6.3.3 Semen and embryos from FMD-susceptible animals

See Appendix 2 for permit conditions.

Permits will only be issued for semen and embryos from susceptible species from establishments where applications are accompanied by evidence of an operational biosecurity manual, including maintenance of biosecurity procedures, accurate record keeping, and permanent identification of all semen/embryo straws and vials.

Permits must not be issued if semen or embryos of higher-risk FMD status have been added to the container, or if fresh liquid nitrogen has not been used.

A risk assessment must be conducted for movements that require an SpP to ensure that the risk associated with movement is acceptable within the response, including the absence of clinical signs of FMD in all susceptible animals on the collection premises for at least 28 days before the time of collection for both fresh and frozen semen, and for 28 days after collection for frozen semen, and no introductions of susceptible animals onto the property during the 28 days before collection.

Table 6.3 describes the recommended movement controls for semen and embryos from FMD-susceptible animals within and between declared areas.

Semen that has been treated in a way that inactivates FMD virus will be subject to jurisdictional risk assessments, which may conclude that semen is not subject to movement restrictions.

<sup>62</sup> There is an appropriate curfew for stock before being transported, an effluent containment tank is in place on the vehicle, and a plan is in place for disposal of effluent.

<sup>63</sup> <https://animalhealthaustralia.com.au/nationally-agreed-standard-operating-procedures/>

<sup>64</sup> <https://animalhealthaustralia.com.au/nationally-agreed-standard-operating-procedures/>

**Table 6.3 Recommended movement controls for semen and embryos from FMD-susceptible animals<sup>65</sup> (See Appendix 2 for permit conditions)**

To→ From <sup>a</sup> ↓		RA			CA			OA
		IP, DCP, SP	ARP	TP	SP	POR	TP	
RA	IP, DCP, SP, TP	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited
	ARP	Prohibited	Prohibited, except under SpP — conditions r, s, t, w, bb, cc <sup>b</sup> , dd, n, o	Prohibited, except under SpP — conditions r, s, t, w, bb, cc <sup>b</sup> , dd, n, o	Prohibited	Prohibited, except under SpP — conditions r, s, t, w, bb, cc <sup>b</sup> , dd, n, o	Prohibited, except under SpP — conditions r, s, t, w, bb, cc <sup>b</sup> , dd, n, o	Prohibited
CA	SP, TP	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited
	POR	Prohibited	Prohibited, except under SpP — conditions r, s, t, w, bb, cc <sup>c</sup> , dd, n, o	Prohibited, except under SpP — conditions r, s, t, w, bb, cc <sup>c</sup> , dd, n, o	Prohibited	Prohibited, except under SpP — conditions r, s, t, w, bb, cc <sup>c</sup> , dd, n, o	Prohibited, except under SpP — conditions r, s, t, w, bb, cc <sup>c</sup> , dd, n, o	Prohibited
OA		Prohibited	Prohibited, except under GP — conditions r, s, t, bb, n, o	Prohibited, except under SpP — conditions r, s, t, w, bb, n, o	Prohibited	Prohibited, except under GP — conditions r, s, t, bb, n, o	Prohibited, except under SpP — conditions r, s, t, w, bb, n, o	Allowed under normal jurisdictional requirements

ARP = at-risk premises; CA = control area; DCP = dangerous contact premises; IP = infected premises; OA = outside area; POR = premises of relevance; RA = restricted area; SP = suspect premises; SpP = special permit; TP = trace premises

a. For semen and embryos, this column refers to the location of the premises where the semen or embryos were collected and not where they are stored.]

b. For stage 2 and 3 of live animal movement controls.

c. For stage 2 only of live animal movement controls.

### 6.3.4 Meat and meat products (including carcasses and offal) of FMD-susceptible animals

See Appendix 2 for permit conditions.

Meat and meat products (including carcasses and offal) of FMD-susceptible animals from low-risk premises do not present a significant risk of FMD virus transmission unless fed to FMD-susceptible animals; therefore, movement of these products would generally be allowed from approved abattoirs. Movement within and out of declared areas will, however, be subject to risk assessment and increased biosecurity measures for the purposes of traceability and minimising indirect disease transmission routes (e.g. from vehicles).

Routine movements of meat and meat products may be delayed in the initial stages of a response while biosecurity measures and approvals or permits are put in place. Where premises are classified as an IP, SP, TP or DCPF, movement will be prohibited. Meat movements out of premises that are unclassified registered processing facilities<sup>66</sup> will be prohibited from the RA into the CA or OA until the status is resolved. In the CA,

<sup>65</sup> Active consideration is being given to risk-managed movements of semen. This includes consideration of a condition requiring delivery to an off-site location where susceptible livestock are not housed or handled.

<sup>66</sup> These are registered processing facilities that are not classified as either DCPFs or APFs.

meat movements from unclassified registered processing facilities can be made under GP with conditions x and aa.

Where FMD-free zones are implemented for trade purposes, additional restrictions may be applied.

Increased awareness of prohibitions on feeding prohibited pig feed, as well as reassurance on the safety of meat for human consumption, should be part of the media campaign.

No meat, meat products or carcasses from FMD-susceptible animals, including field-shot animals, from premises that are not registered abattoirs or commercial meat processing enterprises should be moved within or out of either the RA or the CA.

Table 6.4 describes the recommended movement controls for meat and meat products (including carcasses and offal) of FMD-susceptible animals within and between declared areas.

**Table 6.4 Recommended movement controls for meat and meat products (including carcasses and offal) of FMD-susceptible animals from registered commercial abattoirs and commercial meat processing enterprises**

To→ From ↓		RA	CA	OA
RA	Commercial processing enterprises designated as IP, SP, TP, DCPF	Prohibited	Prohibited	Prohibited
	APF	Prohibited, except under SpP — conditions w, x, y, z, aa	Prohibited, except under SpP — conditions w, x, y, z, aa)	Prohibited
CA	Commercial processing enterprises designated as SP, TP, DCPF	Prohibited	Prohibited	Prohibited
	APF	Prohibited, except under GP — conditions x, aa	Prohibited, except under GP — conditions x, aa	Prohibited, except under GP — conditions x, aa
OA		Allowed under normal jurisdictional requirements	Allowed under normal jurisdictional requirements	Allowed under normal jurisdictional requirements

APF = approved processing facility; CA = control area; DCPF = dangerous contact processing facility; GP = general permit; IP = infected premises; OA = outside area; RA = restricted area; SP = suspect premises; SpP = special permits; TP = trace premises;

Note: Meat derived from animals moved from low-risk premises, as is a requirement for classification as an APF, will be considered low risk. The risk profile of supply premises is covered by the recommended movement controls on live susceptible animals in stages 2 and 3 (Table 6.1).

### 6.3.5 Milk and dairy products

**Table 6.5a Recommended movement controls for raw milk and dairy products to the RA.**

For multiple movements associated with 'milk runs' (e.g. milk pickups from multiple farms en route to a final destination), each movement should be considered individually and should generally be from a lower risk premises to a higher risk premises.

Permit conditions are provided in Appendix 2b.

From \ To		RA								
		IP	DCP	SP	TP	ARP	DCPF	APF	ADS	
RA	IP	Prohibited, except under SpP — conditions 2, 4, 5, 7, 8, 10	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 10
	DCP	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 10	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 10	
	SP	Prohibited, except under SpP — conditions 2, 4, 5, 7, 8, 10	Prohibited	Prohibited, except under SpP — conditions 2, 4, 5, 7, 8, 10	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 10	
	TP	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 10	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 10	
	ARP	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 10	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 10	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 10	
	DCPF	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 10	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 10	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 10	
	APF	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 10	Prohibited, except under GP — conditions 2, 3, 4, 5, 7	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 10	
	ADS	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	
CA	DCP	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 9, 10	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 9, 10	

From \ To		RA							
		IP	DCP	SP	TP	ARP	DCPF	APF	ADS
	<b>SP</b>	Prohibited, except under SpP — conditions 2, 4, 5, 7, 8, 9, 10	Prohibited	Prohibited, except under SpP — conditions 2, 4, 5, 7, 8, 9, 10	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 9, 10
	<b>TP</b>	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 9, 10	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 9, 10
	<b>POR</b>	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 9, 10	Prohibited except under GP — conditions 1, 2, 3, 4, 5, 7	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 9, 10
	<b>DCPF</b>	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 9, 10	Prohibited except under SpP — conditions 2, 3, 4, 5, 7, 9, 10	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 9, 10
	<b>APF</b>	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 9, 10	Prohibited, except under GP — 2, 3, 4, 5, 7, 9	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 9, 10
	<b>ADS</b>	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited
<b>OA</b>	<b>Premises with susceptible livestock</b>	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under GP — conditions 1, 2, 3, 4, 5, 7, 9	Prohibited, except under GP — conditions 1, 2, 3, 4, 5, 7, 9	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 8, 9, 10
	<b>APF</b>	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 9, 10	Prohibited, except under GP — conditions 2, 3, 4, 5, 7, 9	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 9, 10

Table 6.5b Recommended movement controls for raw milk and dairy products to the CA and OA

From \ To		CA						OA		
		DCP	SP	TP	POR	DCPF	APF	ADS	Premises with susceptible livestock	APF
RA	IP	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited except under SpP — 2, 3, 4, 5, 6, 9, 10	Prohibited	Prohibited
	DCP	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited except under SpP — 1, 2, 3, 4, 5, 7, 9, 10	Prohibited	Prohibited except under SpP — 1, 2, 3, 4, 5, 6, 9, 10	Prohibited	Prohibited
	SP	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited except under SpP — 2, 3, 4, 5, 6, 9, 10	Prohibited	Prohibited
	TP	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 9, 10	Prohibited	Prohibited except under SpP — conditions 1, 2, 3, 4, 5, 6, 9, 10	Prohibited	Prohibited
	ARP	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 9, 10	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 9, 10	Prohibited except under SpP — conditions 1, 2, 3, 4, 5, 6, 9, 10	Prohibited	Prohibited
	DCPF	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 9, 10	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 9, 10	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 9, 10	Prohibited	Prohibited
	APF	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 9, 10	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 9, 10	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 9, 10	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 9, 10
	ADS	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited
CA	DCP	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 10	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 10	Prohibited	Prohibited
	SP	Prohibited	Prohibited, except under SpP — conditions 2, 4, 5, 7, 8, 10	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 10	Prohibited	Prohibited

From \ To		CA						OA		
		DCP	SP	TP	POR	DCPF	APF	ADS	Premises with susceptible livestock	APF
	TP	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 10	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 10	Prohibited	Prohibited
	POR	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 10	Prohibited except under GP — conditions 1, 2, 4, 5, 7, 8	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 10	Prohibited except under GP — conditions 1, 2, 3, 4, 5, 7	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 10	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 9, 10
	DCPF	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 10	Prohibited except under SpP — conditions 2, 3, 4, 5, 7, 10	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 10	Prohibited	Prohibited
	APF	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 10	Prohibited, except under GP — conditions 2, 3, 4, 5, 7	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 10	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 9, 10
	ADS	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited
OA	Premises with susceptible livestock	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited, except under SpP — conditions 1, 2, 4, 5, 7, 8, 9, 10	Prohibited except under GP — conditions 1, 2, 4, 5, 7, 8, 9	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 7, 9, 10	Prohibited except under GP — conditions 1, 2, 3, 4, 5, 7, 9	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 9, 10	Allowed under normal jurisdictional or interstate movement requirements.	Allowed under normal jurisdictional or interstate movement requirements.
	APF	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited, except under SpP — conditions 2, 3, 4, 5, 7, 9, 10	Allowed under normal jurisdictional or interstate movement requirements.	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 9, 10	Prohibited	Allowed under normal jurisdictional or interstate movement requirements.

ADS = approved disposal site; APF = approved processing facility; ARP = at-risk premises; CA = control area; CCEAD = Consultative Committee on Emergency Animal Diseases; DCP = dangerous contact premises; DCPF = dangerous contact processing facility; GP = general permit; IP = infected premises; OA = outside area; POR = premises of relevance; RA = restricted area; SP = suspect premises; SpP = special permit; TP = trace premises

### 6.3.6 Wool and other fibres

Wool and other fibres (such as cashmere and alpaca fleece) will only be permitted to leave premises in the RA and CA to go to a premises where there are no susceptible animals under one of the following conditions:

- disinfection of the outside of the bales with an appropriate treatment at the site of origin, or
- storage for an appropriate time and at an appropriate temperature that ensures inactivation of FMD virus.

Bales moved to other sites within 14 days (minimum) before the original premises was designated as an IP require disinfection of the outside of the bales. The bales must be stored for an appropriate time and at an appropriate temperature at the second site that ensures inactivation of FMD virus.

Movement will be subject to permit after verification of the correct treatment or storage.

### 6.3.7 Other animal byproducts

Animal byproducts — including skins, hides, horns, hoofs, knackery products and rendered material — from DCPFs or other high-risk premises may need to be transported off-site for disposal. This material should not be transported outside the RA or the CA in which the establishment is located. If movement of byproducts from high-risk premises is required, it should only be to premises without animals.

The following permit conditions apply to movements to a biosecure disposal or rendering facility:

- Animal byproducts are transported in a biosecure manner (i.e. in a manner that prevents leakage of materials from the transport vehicle).
- Transport is by an approved route.
- The material is not brought into direct or indirect contact with susceptible species.
- After transportation, vehicles are decontaminated appropriately and in accordance with the **AUSVETPLAN Operational manual: *Decontamination***.

The **AUSVETPLAN Operational manual: *Disposal*** provides details on composting and other disposal options.

Once potentially infected byproducts are accepted by a site, that site will be designated as a DCP; therefore, careful consideration should be given to the disposal site and the need to limit access of susceptible species to that site for an appropriate period.

Animal byproducts from higher-risk premises that are destined for use rather than disposal (e.g. hides, skins) must be appropriately decontaminated to inactivate FMD virus.

### 6.3.8 Waste products and effluent

See Appendix 2 for permit conditions.

Waste products and effluent need to be appropriately managed to minimise the risk of exposing susceptible animals to contamination. The **AUSVETPLAN Operational manual: *Decontamination*** provides specific details of procedures to reduce the infectivity of effluent, and the **AUSVETPLAN Operational manual: *Disposal*** provides details on composting and other disposal options.

Because effluent (e.g. manure, yard washings) can transmit FMD virus, it should preferably be disposed of on-site. If movement of effluent from high-risk premises is required, it should only be to premises that exclude animals (i.e. using exclusion fencing). Once potentially contaminated effluent is accepted by a site, that site will be designated as a DCP; therefore, careful consideration should be given to the disposal site and the need to limit access of susceptible species to that site for an appropriate period.

Table 6.6 describes the recommended movement controls for waste products and effluent within and between declared areas.

**Table 6.6 Recommended movement controls for waste products and effluent**

To→ From ↓		RA		CA			OA
		IP, DCP, SP, TP, ARP	ZP/ADS	SP, TP <sup>a</sup>	POR	ZP/ADS	
RA	IP, DCP	Prohibited	Prohibited, except under SpP — conditions d, g, i, p, v <sup>b</sup>	Prohibited	Prohibited	Prohibited, except under SpP — conditions d, g, i, p, v <sup>b</sup>	Prohibited
	SP, TP <sup>a</sup>	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited
	ARP	Prohibited	Prohibited, except under SpP — conditions d, g, i, p, v	Prohibited	Prohibited	Prohibited, except under SpP — conditions d, g, i, p, v	Prohibited
CA	SP, TP <sup>a</sup>	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited
	POR	Prohibited	Prohibited, except under SpP — conditions d, g, i, p, v <sup>c</sup>	Prohibited	Prohibited, except under SpP — conditions d, g, i, p, v	Prohibited, except under SpP — conditions d, g, i, p, v	Prohibited
OA		Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Allowed under normal jurisdictional requirements

ADS = approved disposal site; ARP = at-risk premises; CA = control area; DCP = dangerous contact premises; IP = infected premises; OA = outside area; POR = premises of relevance; RA = restricted area; SP = suspect premises; SpP = special permit; TP = trace premises; ZP = zero susceptible species premises

a TPs and SPs are temporary classifications, and every effort should be made to resolve the status of these premises as soon as possible.

b Sites receiving effluent and waste from high-risk premises will be designated as DCPs, and an RA would be designated around the site.

c This should be the only option available, to minimise the amount of CA effluent and waste being disposed of in RA disposal sites.

### 6.3.9 Other vehicles and equipment, such as mining trucks, feed trucks, utilities vehicles and wind farm vehicles not covered in another matrix

See Appendix 2 for permit conditions.

Table 6.7 describes the recommended movement controls for vehicles and equipment that have had direct contact with susceptible animals, their products or wastes, or areas where susceptible animals have been, where such vehicles are not covered in another matrix.

**Table 6.7 Recommended movement controls for vehicles and equipment that have had direct contact with susceptible animals, their products or wastes, or areas where susceptible animals have been, where such vehicles are not covered in another matrix**

To→ From ↓		RA	CA	OA
RA	IP, SP, TP, DCP DCPF	As determined by property specific jurisdictional legislative orders	As determined by property specific jurisdictional legislative orders	As determined by property specific jurisdictional legislative orders
	ARP, APF	Prohibited, except under GP <sup>a</sup>	Prohibited, except under GP <sup>a</sup>	Prohibited, except under GP <sup>a</sup>
CA	SP, TP	As determined by property specific jurisdictional legislative orders	As determined by property specific jurisdictional legislative orders	As determined by property specific jurisdictional legislative orders
	POR	Prohibited, except under GP <sup>a</sup>	Prohibited, except under GP <sup>a</sup>	Prohibited, except under GP <sup>a</sup>
OA		Allowed under normal jurisdictional requirements	Allowed under normal jurisdictional requirements	Allowed under normal jurisdictional requirements

APF = approved processing facility; ARP = at-risk premises; CA = control area; DCP = dangerous contact premises; DCPF = dangerous contact processing facility; GP = general permit; IP = infected premises; OA = outside area; POR = premises of relevance; RA = restricted area; SP = suspect premises; TP = trace premises

a GP conditions are that the vehicles and equipment must be decontaminated before entering the premises at an appropriate site (e.g. truck wash-down facility at an abattoir, where available) using a protocol provided by the response authority, and records are kept of the movement and decontamination protocol used.

### 6.3.10 Nonsusceptible animals

Proposed movements of nonsusceptible animals off high-risk premises (IPs, SPs, TPs, DCPs and DCPFs) should be subject to risk assessment to prevent the mechanical spread of FMD virus.

Where these animals may be potentially contaminated with FMD virus, they should be subject to appropriate decontamination procedures before their movement is allowed.

Movements of nonsusceptible animals onto and off other premises with susceptible animals in RAs should be discouraged.

Movements of nonsusceptible animals in the CA and OA should not be restricted.

### 6.3.11 People

People may act as contaminated fomites and so play a role in spread of infection.

The conditions applied to movements of people off IPs, DCPs, SPs and TPs should be based on risk assessment, taking into consideration any potential contact with livestock and contaminated environments. Where the assessed risk is high, a change of clothes, headwear and footwear, or decontamination procedures, and record keeping should be implemented. Since viruses can be transmitted in nasal cavities, hair and so on, consideration should also be given to the need for showering before entering another property where there are susceptible animals.

For ARPs, PORs and premises in the OA, owners should be encouraged to enhance biosecurity measures to limit the movement of potential environmental contaminants (see also Section 4.3.3).

### 6.3.12 Specimens

Specimens for laboratory investigation should be handled according to the advice in Section 2.5.4. In some jurisdictions, a permit may be required for these movements.

### 6.3.13 Crops, grains, hay, silage and mixed feeds

Movements of feeds onto high-risk premises (IPs, SPs, TPs and DCPs) may be necessary for animal welfare reasons; these would be permitted, provided that the requirements for people, vehicle and equipment movements are met.

Movements of crops, grains, hay and silage harvested from high-risk premises (IPs, SPs, TPs and DCPs), or mixed feeds made from such constituents, should be subject to risk assessment on a case-by-case basis.

Crops, grains, hay and silage that may be potentially contaminated with FMD virus should be decontaminated before their movement is permitted (see the **AUSVETPLAN Operational manual: Decontamination**). For example, crops, grains, hay and silage harvested from paddocks that were sprayed or treated with effluent from susceptible animals on quarantined premises in the period commencing 14 days before the first signs of FMD on a premises — or mixed feeds made from such constituents — should be considered contaminated.

Crops, grains, hay and silage from other premises may be moved provided that any applicable requirements for people, vehicle and equipment movements are met.

### 6.3.14 Sales, shows and other events

All aggregations of live susceptible animals (e.g. sale, shows, scales operations.) within the RA are prohibited.

Events such as sales and shows in the CA and OA may proceed during stage 2 at the discretion of the relevant jurisdictional CVO, informed by risk assessment.

Movements of vehicles, equipment and people for such sales, shows and events should be in accordance with Sections 6.3.10, 6.3.11 and 6.3.12.

### **6.3.15 Stock routes and rights of way**

Stock routes and rights of way in the RA should be closed for the duration of the response. Stock already present on these areas will need to be managed.

Stock routes and rights of way in the CA and OA may be opened at the discretion of the relevant jurisdictional CVO, informed by risk assessment.

Any susceptible live animals currently located within a stock route should be considered with regard to movement or classification as if they were in an IP, SP or TP.

### **6.3.16 Animal movements for emergency (including welfare) reasons**

Movements of susceptible animals that are otherwise prohibited may be considered on a case-by-case basis (informed by risk assessment) for emergency (including welfare) reasons. Examples are movements for emergency veterinary treatment and movements to different premises to manage welfare concerns (e.g. feed, space, milking availability).

If allowed, such movements will be under approval from the relevant CVO or delegate (emergency permit) after assessment<sup>67</sup> indicates that the risk associated with the movement is acceptable within the response.

### **6.3.17 Other movements**

Movements of other risk materials will need to be considered on a case-by-case basis, informed by risk assessment.

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<sup>67</sup> Assessment may include diagnostic testing of live susceptible animals scheduled for movement, or background surveillance testing of 'normal' sick and dead animals to exclude FMD.

# 7 Surveillance and proof of freedom

## 7.1 Surveillance

The key objectives and priorities for surveillance in response to an outbreak of foot-and-mouth disease (FMD) are outlined in Section 4.3.5.

### 7.1.1 Specific considerations

Specific considerations for surveillance for FMD include the following:

- FMD affects a wide range of livestock and feral animal species.
  - Pigs are the main amplifying hosts and may excrete large volumes of virus in respiratory aerosols — susceptible species downwind from pig farms or a high density of feral pigs may be infected by windborne spread.
  - Cattle are more susceptible to aerosol infection (windborne spread) than sheep or pigs.
  - Cattle are the major clinical indicator species.
  - Infected sheep, goats, deer and camelids might show mild or inapparent signs, so disease may go undetected on clinical examination.
- Polymerase chain reaction (PCR) testing on pooled oral swabs, bulk milk tests or ‘chew’ ropes placed in pig pens is a highly sensitive method (Vosloo et al 2012) to detect FMD virus infection once viral shedding has commenced (which may be before clinical signs are evident). This approach to surveillance may be less resource-intensive and require less veterinary expertise than traditional surveillance methods (e.g. by individual visual inspection of at-risk animals).
- Assessment of the priority for surveillance of dairy farms that are suspect premises (SPs), trace premises (TPs) or dangerous contact premises (DCPs) should take into consideration the likely milk volumes that may accumulate (and require disposal).
- Surveillance of feral populations of susceptible animals (pigs, goats, cattle, buffalo, deer) in areas where disease is present will be important to assess whether they may be acting as reservoirs of infection and to provide evidence to support proof of freedom.
- If vaccination is used as part of the disease response, use of laboratory tests that allow differentiation of vaccinated from infected animals will be important.

The types of surveillance that are most appropriate for FMD are:

- active surveillance of TPs to determine whether they contain infected animals or contaminated items
- active surveillance of all premises within the restricted area (RA) with susceptible species
- enhanced passive surveillance to detect premises and susceptible feral animal populations with animals showing clinical signs not identified through tracing; this will involve encouraging producers, animal health professionals, other relevant members of the livestock industry supply chain, hunters, Indigenous rangers, zoos and so on to report livestock and other susceptible animals with signs consistent with FMD
- active surveillance at congregation points such as milk processors (bulk milk testing), saleyards and abattoirs.

Active surveillance of healthy susceptible species with no known links to the outbreak is unlikely to be an efficient way of detecting cases of FMD. However, it could be considered in some situations — for example,

if producer reporting is not adequate for the population at risk (e.g. feral animal populations), for a widespread outbreak or for proof of freedom.

## **7.1.2 Premises surveillance**

### **Domestic animals**

#### **Surveillance on infected premises (IPs)**

Surveillance on IPs may be useful to:

- confirm the infection status of any rare and valuable animals (particularly if alternative disease control measures are being considered)
- aid epidemiological understanding of the outbreak — for example, by
  - clinical monitoring if the presentation of FMD is atypical
  - genetic mapping or other characterisation of the virus present — for example, if the IP is not linked to other areas of infection, or periodically throughout the outbreak to monitor for changes.

Where laboratory investigation is required, the selection of animals to sample should be risk based, considering the presence of distinct epidemiological units or groups of animals on the premises. It should include sufficient animals to be representative of each distinct population present. Animals of susceptible species to target for sampling include:

- animals showing clinical signs consistent with FMD
- recently dead or euthanased animals
- the most susceptible animals (considering species, age, etc)
- animals introduced to the premises in the tracing window of interest (as these may be a source of infection)
- animals more likely to be infected (e.g. animals with a history of recent exposure to other animals, breeding males with high numbers of recent matings, animals returned from shows)
- rare and valuable animals.

#### **Surveillance on suspect premises (SPs)**

Veterinary investigation of SPs is a priority and should occur as soon as practical after suspicious signs are recognised and reported.

Given the wide host range of FMD, it is possible that a large number of SPs will require investigation. Where available resources are limited, further prioritisation may be required. This should take into consideration the likelihood that infection may be present, and the risk of further disease transmission and dissemination if the animals are infected. General principles are as follows:

- SPs with epidemiological links to known IPs are a higher priority, and SPs with no epidemiological links to IPs are a lower priority. (Clinical signs similar to FMD may have an endemic cause, and many reports of suspicious clinical signs will not be due to FMD. However, to ensure that producers are not discouraged from reporting, it is important that surveillance to resolve these cases is conducted in as timely a manner as possible.)
- SPs in the outside area (OA) are a higher priority for investigation than those in the control area (CA) or RA.

- SPs in the CA are a higher priority for investigation than those in the RA.
- SPs with rare and valuable animals are a higher priority for investigation than those of equivalent risk status but without such animals.

On SPs, the approach to surveillance should be as follows:

- All susceptible animals on the premises should be observed for clinical signs that are consistent with FMD (although this may not be practical or possible on extensive premises).
- Targeted examination and sampling should be undertaken to maximise the likelihood of detecting FMD if it is present. This should be consistent with the recommended approach to targeted sampling on IPs.
- Targeted sampling should be supplemented by sampling for serological testing of healthy susceptible animals in the same epidemiological unit or cohort as the animals targeted. Detection of seroconversion will help indicate how long FMD virus has been present on the premises and provide data for epidemiological investigations.
- If not already undertaken, an investigation should be conducted to determine whether the premises is epidemiologically linked to the outbreak.

If adequate samples have been taken (in terms of both quality and quantity), the laboratory results are negative for FMD virus, and epidemiological investigation of the premises is complete with no additional risk materials identified, the premises may be assessed negative and designated with the 'AN' qualifier. If it is located in the RA, it will then be reclassified as an at-risk premises (ARP) with the qualifier AN (ARP-AN). If it is located in the CA, it will be classified as a premises of relevance (POR) with the qualifier AN (POR-AN). If it is located in the OA, the premises will resume its usual status and previous business.

### **Surveillance on trace premises (TPs)**

Where the number of TPs for investigation is large and available resources are limited, further prioritisation may be required. This should take into consideration the likelihood that infection may be present, and the risk of further disease transmission and dissemination if the animals are infected. Animal welfare should also be considered in prioritising and resolving TPs.

The owner or managers of TPs waiting for a surveillance visit should be encouraged to report any clinical signs or changes in production statistics consistent with FMD.

The approach to surveillance of live susceptible animals on TPs should be consistent with the guidance for surveillance on SPs.

If live susceptible animals on the premises show clinical signs consistent with FMD, the premises should be considered an SP, and the guidance on surveillance and assessment of SPs followed.

In addition, where the premises was identified through tracing of contaminated animal products, wastes or things, these items should also be subject to surveillance, including sampling for laboratory investigation, where warranted (e.g. using molecular techniques such as PCR testing where FMD virus contamination cannot be otherwise ascertained).

If the TP has no live susceptible species, the premises may be considered as assessed negative if the investigation shows no evidence of FMD virus. For example, this might occur if the potentially contaminated items are no longer on the premises, laboratory investigation of potentially contaminated items returns negative results or the potentially contaminated items are decontaminated.

If live susceptible species on the premises do not show clinical signs of FMD, the premises may be considered for ongoing surveillance over a 14–28-day period (1–2 incubation periods) or may be resolved to ARP/POR status.

## **Surveillance on dangerous contact premises (DCPs) and dangerous contact processing facilities (DCPFs)**

Surveillance of susceptible animals on DCPs and DCPFs should be consistent with the guidance for surveillance on SPs.

As for TPs, where the premises has been allocated its status because of the potential presence of contaminated animal products, wastes or things (e.g. the environment, feed), these items should also be subject to surveillance. Surveillance should include sampling for laboratory investigation, where warranted.

The approach to resolving DCPs and DCPFs following completion of control activities is outlined in Section 5.4 and the **AUSVETPLAN Guidance document: *Declared areas and allocation of premises definitions in an emergency animal disease response***.

## **Surveillance on other premises with live susceptible animals (ARPs in the RA, PORs in the CA, and premises in the OA)**

The aim of surveillance on ARPs, PORs and premises in the OA will be to detect infection (new IPs) as early as possible, while minimising opportunities for inadvertent spread of FMD virus through field visits.

Methods of surveillance may include:

- inspection of all at-risk mobs or groups by owners or managers
- veterinary investigation of syndromes consistent with FMD
- monitoring and review of production records and producer health reports by local control centre surveillance staff
- phone interviews
- bulk milk testing
- collection of oral swabs from carcasses at abattoirs (with pooling of samples from the same consignment)
- collection of pooled oral swabs from healthy flocks and herds
- testing of 'chew' ropes from healthy pig herds
- pen-side testing.

The frequency and method(s) of surveillance chosen for individual premises will depend on the assessed risk (including from airborne transmission), the number of premises to monitor (the size of the outbreak) and the available resources.

The initial approach to surveillance on other premises with live susceptible animals would include raising awareness of the possible clinical presentations of FMD, and encouraging producers or owners to report clinical signs or changes in production statistics. Biosecurity advice should also be provided to help prevent the introduction or further spread of disease.

Surveillance visits would be risk based; for example, ARPs may be considered a higher priority for such visits, particularly ARPs in close proximity to IPs or predicted to be at risk of windborne spread. Collection of samples (e.g. oral swabs) from these premises for pooled testing may improve confidence that infection will be detected if present.

The timing and frequency of active surveillance visits in the CA and OA may differ from those in the RA. For logistical purposes (and to minimise the risk of disease spread), it may be useful to separate management and resourcing of surveillance in the CA from that in the RA.

Additional surveillance activities on these premises may subsequently be required to provide evidence to support proof of freedom.

### 7.1.3 Surveillance of sentinel animals placed after destocking of IPs and DCPs

The aim of surveillance on an IP or DCP following destocking and decontamination is to confirm that FMD virus is not present on the premises. Once a premises has been resolved, restocking will be conditional on approval from the jurisdictional chief veterinary officer (e.g. subject to receipt of seronegative test results). It would normally be done on an area basis rather than a premises basis.

In developing a surveillance plan for resolution of IPs or DCPs, consideration is given to the actual number of infected animals rather than the prevalence. When only one animal in the group is infected, testing all animals in the group results in a probability of detection equal to the sensitivity of the test. If the group contains two infected animals, the probability of detection increases to more than 0.95 as long as the test has a sensitivity of 80% or more; for example, a sample size of 100 will allow detection of at least 3% prevalence (0.95 probability) using a test with 95% sensitivity (see table below).

Table F-3. Sample sizes<sup>1</sup> and number of infected animals for six prevalence values and a range of group sizes. Sample sizes achieve 0.95 probability of detection using a 95 percent sensitive test.

Group size <sup>2</sup>	1% prevalence		2% prevalence		3% prevalence		5% prevalence		10% prevalence		15% prevalence	
	No. infected animals	Sample size	No. infected animals	Sample size	No. infected animals	Sample size	No. infected animals	Sample size	No. infected animals	Sample size	No. infected animals	Sample size
100	1	95	2	77	3	63	5	44	10	25	15	25
150	1	143	3	94	4	78	7	51	15	26	22	26
200	2	155	4	105	6	78	10	51	20	27	30	27
250	2	194	5	112	7	86	12	54	25	27	37	27
300	3	189	6	117	9	84	15	53	30	27	45	27
400	4	210	8	124	12	87	20	54	40	27	60	27
600	6	235	12	131	18	91	30	56	60	28	90	28
800	8	249	16	135	24	93	40	56	80	28	120	28
1000	10	258	20	138	30	94	50	57	100	28	150	28
>5000	... <sup>3</sup>	298	... <sup>3</sup>	148	... <sup>3</sup>	98	... <sup>3</sup>	58	... <sup>3</sup>	28	... <sup>3</sup>	28

<sup>1</sup> Sample sizes computed using Cannon, 2001.

<sup>2</sup> Group size refers to the size of the population being sampled. This could be the entire herd or it could be a targeted portion of the herd such as the sick animals or animals with potential exposure.

<sup>3</sup> Depends on group size

Jurisdictions need to consider the desired level of certainty and prevalence that is required to resolve the property status.

#### Restocking guidance

Following successful decontamination protocols, an IP will remain vacant for a period before being restocked with susceptible species. The minimum recommendation is 28 days (two World Organisation for Animal Health (WOAH) incubation periods).

If it is not possible to carry out full decontamination protocols, the premises may need to remain vacant for a longer period, based on consideration of virus survival, environmental conditions and the specific circumstances of the outbreak. This will be determined on a case-by-case basis.

A restocking plan should include details of the:

- susceptible species — any FMD-susceptible species is appropriate, although the use of sheep as sentinel animals should be discouraged
- number of sentinel animals (to provide epidemiologically sound results)
- proposed locations of sentinel animals.

Restocked animals should undergo a clinical investigation every 3 days for the first 14 days, and then once per week up to 28 days.

Each animal must be clinically examined by a veterinary inspector and sampled for the presence of FMD virus antibody 28 days after the last animals are introduced.

## Surveillance of wild and free-roaming animals

A surveillance program may be required for surveillance of wild and free-roaming susceptible species.

Early identification of susceptible wild and free-roaming animal species, and the geographical extent of the disease are key requirements for managing an outbreak. Sampling for disease in wild animal populations can indicate the presence and geographical extent of the disease, and in some cases give an indication of prevalence (i.e. the proportion of the population affected) in these populations.

Engaging a wild animal expert to assist in planning and implementing a surveillance program is recommended.

At the end of an eradication campaign, sampling of wild animals may be required to prove freedom from the disease.

Guidelines for wild animal surveillance are further discussed in the **AUSVETPLAN Operational manual: *Wild animal response strategy***.

Refer to Section 4.3.14 for further information about the control of susceptible wild (including feral) animal populations.

## 7.2 Proof of freedom

Following an outbreak of FMD, surveillance will be required to demonstrate that infection has been eradicated from susceptible domestic and feral animal populations, and enable any remaining movement restrictions to be lifted within the country or zone. Proof of freedom will also be needed to satisfy trading partners and regain access to international markets, and to underpin import controls to prevent the reintroduction of FMD virus.

WOAH has the mandate from the World Trade Organization to officially recognise FMD-free areas of countries for trade purposes.<sup>68</sup> Any application to WOAH regarding recognition of Australia's FMD status should be based on the WOAH *Terrestrial animal health code* chapters on FMD (Chapter 8.8)<sup>69</sup> and general surveillance (Chapter 1.4),<sup>70</sup> as well as the WOAH FMD questionnaire (Article 1.6.6).<sup>71</sup> The application will require submission of a formal report to WOAH, detailing the eradication procedures carried out, the surveillance program undertaken and the results obtained. Where a zonal approach to control has been taken, increased surveillance and movement restrictions in protection zones may also be applied.

However, although WOAH provides guidelines for recovering FMD-free status, acceptance of FMD-free status following an outbreak will most likely have to be negotiated with individual trading partners and may take considerably longer than the minimum periods prescribed in the WOAH Terrestrial Code.

A key requirement for WOAH and trading partners will be evidence of an effective surveillance program capable of detecting infection if it is present in the population, and analysis of data to support the case for disease freedom. Descriptions of the veterinary services, demographics of susceptible populations, animal identification, records of movement and relevant industry structures should be included to justify the design of the surveillance program.

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<sup>68</sup> [www.woah.org/en/what-we-do/animal-health-and-welfare/official-disease-status/](http://www.woah.org/en/what-we-do/animal-health-and-welfare/official-disease-status/)

<sup>69</sup> [www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=chapitre\\_fmd.htm](http://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=chapitre_fmd.htm)

<sup>70</sup> [www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=chapitre\\_surveillance\\_general.htm](http://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=chapitre_surveillance_general.htm)

<sup>71</sup> [www.woah.org/fileadmin/Home/eng/Health\\_standards/tahc/2016/en\\_chapitre\\_selfdeclaration.htm](http://www.woah.org/fileadmin/Home/eng/Health_standards/tahc/2016/en_chapitre_selfdeclaration.htm)

## 7.2.1 Principles for designing a post-outbreak surveillance program

To provide confidence that FMD virus is no longer circulating,<sup>72</sup> a comprehensive surveillance program will be required. Specific recommendations for surveillance to support proof of freedom will be developed using the technical expertise of competent and experienced epidemiologists, and will be based on the characteristics of the outbreak and the animal production sectors involved. The surveillance program will need to be carefully designed and followed to ensure that it produces sufficient data that are reliable and acceptable to WOAHA and international trading partners, while avoiding a program that is excessively costly and logistically complicated. The surveillance program will include clinical, serological and molecular surveillance of relevant susceptible domestic and feral animal populations. It will include targeted and random components, and will build on the surveillance, diagnostic testing, tracing and epidemiological assessment conducted during the response phase.

### Clinical surveillance

The aim of clinical surveillance is to physically examine susceptible animals for clinical signs of FMD. In addition to clinical and/or laboratory investigation of suspect cases reported to authorities (passive surveillance), active surveillance will also be required to look for the disease in groups of animals seen as being at particularly high risk. The absence of FMD infection will support proof of freedom.

The approaches used for clinical surveillance will be a continuation of measures in place during the response and should include:

- a public relations and awareness campaign for producers and animal health professionals (e.g. veterinarians, stock inspectors, meat inspectors) to immediately report suspicions of vesicular disease to government veterinary services
- enhanced clinical inspection of livestock at abattoirs, saleyards and other aggregation points
- an official alert system deployed on SPs pending diagnosis
- effective veterinary investigations and diagnostic services that demonstrate that suspect cases are promptly investigated
- use of a standardised investigation protocol and reporting forms.

### Serological surveillance

Regardless of whether vaccination has been used in the response, the WOAHA Terrestrial Code identifies serological surveillance as a key element for demonstrating FMD freedom. Serological surveillance aims to detect evidence of exposure to FMD virus. It may be based on targeted or random sampling, or a combination of both. Generally, a targeted approach would be used to verify the status of specific groups or sectors of the population considered to be at higher risk of exposure; for example, herds in former RAs and CAs may be targeted because of proximity to cases, and sheep may be targeted because they are less likely to show clinical evidence of infection than other susceptible species.

Surveys based on random sampling are important in providing reliable evidence that FMD virus infection is not present in a country. The sampling strategy will be designed to demonstrate the absence of FMD virus circulation at an acceptable level of statistical confidence. Important factors that need to be taken into account when designing the sampling regime include:

- design prevalence — the minimum level of infection that would be detected if the disease is present

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<sup>72</sup> According to WOAHA, virus circulation means transmission of FMD virus as demonstrated by clinical signs, serological evidence or virus isolation.

- target population — the population under surveillance, which should cover all susceptible species
- level of statistical confidence required in the results
- sensitivity and specificity of diagnostic tests
- sample size — number of herds to be sampled and number of animals to be sampled per herd.

It is impossible to provide specific recommendations to cover all situations, because the characteristics of potential FMD outbreaks in Australia will be highly variable, depending on the strain of virus, the environmental conditions, and the region(s) and populations affected. Technical expertise from professionals who are competent and experienced in epidemiology will be required. Particular attention will need to be paid to selecting an appropriate design prevalence and statistical confidence level for surveys, because these parameters will have to be justified and withstand international scrutiny. Since no diagnostic tests are perfect, the survey design should anticipate the occurrence of false positive reactions and incorporate appropriate follow-up procedures.

### **Surveillance where vaccination is used**

Demonstrating freedom from infection in populations where vaccination has been used will pose additional challenges for post-outbreak surveillance. If vaccination is used as part of the FMD response, the options are to remove the vaccinated animals from the population or to allow them to live out their normal commercial lives. The availability of tests that can differentiate infected from vaccinated animals (DIVA tests) means that it may be possible to allow vaccinated animals to be retained in the population to live out their normal lives. However, there is a preference for removal of vaccinated animals to expedite return to international trade (see Section 4.3.8).

DIVA tests are based on detection of antibodies to nonstructural proteins of the virus. In Australia, DIVA testing would be based on an enzyme-linked immunosorbent assay (ELISA) detecting antibodies to the nonstructural protein 3ABC. This protein is only expressed as the virus replicates in the host, and is either not present at all or present at very low levels in purified inactivated vaccines. Animals vaccinated with purified inactivated vaccines but not exposed to live virus are less likely to develop antibodies to 3ABC, but may develop antibodies after repeated booster vaccinations.

It is important to note that, in animals infected after vaccination, antibodies induced by vaccination inhibit, but do not prevent, replication of the virus. Because the virus replicates at much lower levels, the titres of antibodies to nonstructural proteins such as 3ABC are much lower. As a result, the diagnostic sensitivity for vaccinated animals is lower than for animals infected but not vaccinated. This differential sensitivity must also be considered as part of the sampling strategy. For this reason, the 3ABC ELISA is used on a herd basis. See Section 2.5.5 for further information on DIVA testing.

# Appendix 1 Foot-and mouth disease fact sheet

## Disease and cause

Foot-and-mouth disease (FMD) is caused by FMD virus.

## Occurrence in Australia

Australia is recognised as free from FMD without vaccination.

## Species affected

Domestic and wild cloven-hoofed animals — cattle, pigs, sheep, goats, deer (red, fallow and roe) and water buffalo — are the natural hosts of FMD virus. A few species in other orders are also susceptible.

## Key signs

In cattle, the earliest clinical signs of FMD are dullness, poor appetite and a rise in temperature to 40–41 °C. In dairy cows, milk yield drops considerably. Profuse salivation, nasal discharge and lameness may be observed, depending on the stage of infection. Affected animals move away from the herd and may be unwilling or unable to stand. Lethargy and rapid loss of condition are also features of the disease.

Vesicles may appear inside the mouth, on the tongue, cheeks, gums, lips and/or palate.

## Spread

FMD is one of the most contagious animal diseases.

Movement of infected animals is widely recognised as one of the most important routes by which FMD spreads between herds and farms. Transmission occurs most readily when animals are in close proximity, such as at watering and feeding points, and congregation points such as stockyards and milking sheds.

Animals are infected via inhalation, ingestion and artificial or natural breeding. The primary route of infection in ruminants is inhalation of contaminated aerosols. In contrast, pigs are mainly infected through ingesting contaminated feed.

## Persistence of the agent

FMD virus can remain infective in the environment for several weeks and possibly longer in the presence of organic matter, such as soil, manure and dried animal secretions, or on chemically inert materials, such as straw, hair and leather.

# Appendix 2a Permit conditions, other than for milk and milk products

## General requirements

- a. With CVO approval, for slaughter or destruction at an APF, or to an ARP for other purposes (e.g. health and welfare reasons — feed, water, milking), if a risk assessment indicates that the risk associated with movement is acceptable within the response.
- b. For slaughter only, if the RA contains the only available abattoir, and if a risk assessment indicates that the risk associated with the movement is acceptable within the response.
- c. For slaughter, or to a POR for a specific purpose (e.g. health and welfare reasons — feed, water, milking), if a risk assessment indicates that the risk associated with movement is acceptable within the response. For the purposes of this permit, the definition of POR includes APFs (i.e. an abattoir or knackery or other such plant to which animals have been introduced from lower-risk premises under a permit for processing to an approved standard).
- d. With CVO approval, for disposal or decontamination procedures only.
- e. With CVO approval, for introduction of sentinel stock.
- f. For slaughter or for movements within an enterprise, such as the movement of offspring from a breeding herd to grow-out unit; not for milking.

## Transport requirements

- g. Travel by approved routes and no stopping en route.
- h. The receiving premises must meet minimum biosecurity standards.
- i. Vehicles carrying livestock or products, and associated equipment, to be decontaminated (i.e. cleaned and disinfected) at an appropriate site (e.g. truck wash-down facility) before and after movement. Vehicles and equipment must have adequate contact time with the relevant disinfectant before use, and runoff from the decontamination sites needs to be managed (refer to the **AUSVETPLAN Operational manual: Decontamination** for disinfectant information, adequate contact times and management of runoff).
- j. Single consignment per load.
- k. One-way movement only.
- m. Trucks are appropriately decontaminated as soon as possible after use and before leaving the ADS or POR, and are dry before reuse.

## Disease-related requirements

- n. Absence of clinical signs of FMD in all susceptible animals on the premises before and on day of travel.

- o. Any suspicious or clinically consistent clinical signs of FMD in live susceptible animals proposed to be moved are immediately reported to the local control centre, state coordination centre or Emergency Animal Disease Watch Hotline (1800 675 888).
- p. The material has been treated or held under conditions that would inactivate or securely contain FMD virus before removal to an ADS.

## **Legislative requirements**

- q. All live susceptible animal movements must comply with state or territory legislation related to traceability requirements and standards, and be accompanied by any legislated documentation (e.g. National Vendor Declaration (NVD), waybill)). Traceability must be maintained for a minimum of 30 days for consignments moved to another farm.

## **Other requirements**

- r. The tank or container used for transport is sealed before movement, and disinfected before and after movement.
- s. If the tank or container used for transport has been opened within 28 days from the estimated date of introduction of FMD, a risk assessment is required.
- t. Information is recorded in the permit on the identification codes, species and identity of the sire and/or dam, collection date, and property of collection and destination.
- v. No direct or indirect contact between the effluent and susceptible animals.
- w. A risk assessment indicates that the risk is acceptable within the response.
- x. Vehicles transporting meat and meat products or offal are decontaminated (i.e. external surfaces and the cabin are cleaned and disinfected) before leaving the processing facility with the relevant disinfectant and adequate contact time. Management of refrigerated vehicles — including appropriate decontamination — needs to meet regulatory food safety standards.
- y. The permit accompanies the livestock or vehicle during movement, and the person responsible retains a copy of the permit, consistent with the legal requirements of the jurisdiction.
- z. Only after maturation and deboning, unless otherwise approved by the jurisdiction via the conditions of approval as an APF or on a risk-assessed basis (w).
- aa. As per the prohibited pig feed or restricted animal material requirements, the product is not to be brought into direct or indirect contact with susceptible animals.
- bb. Semen/embryo delivery procedures ensure the courier/transporter does not enter any area where susceptible livestock are housed or handled. Technicians transporting genetic material on-farm to conduct insemination/embryo transfer services are exempt if they meet appropriate biosecurity requirements.
- cc. Diagnostic testing by an AHC or CVO approved testing regime/method may be required, depending on the risk assessment OR semen/embryos are not to be used for two incubation periods without the premises of origin classification changing to IP, DCP, DCPF, ADS, SP or TP.
- dd. Donor/s must be located in a facility/premises that meets an AHC-endorsed biosecurity standard.

## Appendix 2b Permit conditions for raw milk

1. There is no evidence of clinical signs consistent with FMD in susceptible animals on the premises on the day of movement or in the previous 28 days.
2. Milk transport vehicles, personnel and associated equipment are externally decontaminated on entry and exit of the premises, or decontaminated at an alternate location as deemed appropriate by risk assessment.
3. Milk transport vehicles and associated equipment are internally decontaminated after emptying at APF, ADS or DCPF.
4. Milk transport vehicles follow approved milk collection routes to approved destinations, with only pre-approved stops en route.
5. The permit accompanies the vehicle during movement, and the person responsible retains a copy of the permit, consistent with the legal requirements of the jurisdiction. The permit may be paper or digital.
6. Before disposal, an approved treatment process (e.g. heat treatment/pasteurisation (72 °C for 15 seconds), acidification) or approved disposal process of raw milk and milk byproducts is applied to inactivate the FMD virus.
7. Raw milk and milk byproducts are not for consumption by susceptible animals.
8. Raw milk and milk byproducts are to remain contained in the transport vehicle while en route to the processing facility.
9. Where there is not capacity to receive and process or dispose of the milk in the area of collection.
10. Movement will involve a risk assessment to determine whether the risk associated with the movement is acceptable within the response.


## Appendix 3 Estimating the age of lesions of FMD in cattle and sheep

Source: EUFMD (nd)


Day of clinical disease	Appearance of lesion (note: lesions in sheep and goats may be smaller and less pronounced than those in cattle)
Day 1	<p data-bbox="454 419 1227 448">Blanching of epithelium, followed by formation of fluid-filled vesicles</p> 


Day of clinical disease	Appearance of lesion (note: lesions in sheep and goats may be smaller and less pronounced than those in cattle)
	 A close-up photograph of a dark-colored animal's head, likely a pig, showing a lesion on the ear area. A person wearing white gloves is examining the lesion. The lesion appears as a small, reddish, ulcerated area on the skin of the ear. The animal's fur is dark and slightly matted. The background is out of focus, showing some greenery.

Day of clinical disease	Appearance of lesion (note: lesions in sheep and goats may be smaller and less pronounced than those in cattle)
Day 2	<p data-bbox="450 220 1720 256">Freshly ruptured vesicles, characterised by raw epithelium, a clear edge to the lesion and no deposition of fibrin</p>  A close-up photograph of a lesion on a hoof. The lesion is roughly circular and has a central, bright red, granular area. This central area is surrounded by a ring of raw, pinkish, and slightly raised epithelium. The surrounding hoof tissue is a pale, yellowish-tan color. The hoof is being held by a person's hand, which is visible at the bottom of the frame.

Day of clinical disease	Appearance of lesion (note: lesions in sheep and goats may be smaller and less pronounced than those in cattle)
	 A close-up photograph showing a lesion on a hoof, held by white gloves. The lesion is a raised, oval-shaped area with a yellowish, necrotic center and a reddish, inflamed border. The surrounding hoof tissue is dark and textured.

Day of clinical disease	Appearance of lesion (note: lesions in sheep and goats may be smaller and less pronounced than those in cattle)
Day 3	<p data-bbox="450 225 1503 256">Lesions start to lose their sharp demarcation and bright red colour; deposition of fibrin starts</p>  <p data-bbox="450 1078 1861 1377">A close-up photograph of a sheep's mouth, showing the oral cavity. The tongue is visible, and the surrounding mucosal tissue is heavily inflamed, appearing bright red and swollen. There are visible lesions, particularly on the inner surface of the lower lip and the buccal mucosa, characterized by redness and the presence of white, fibrinous deposits. The sheep's teeth are visible, and the overall appearance is one of severe oral disease.</p>

Day of clinical disease	Appearance of lesion (note: lesions in sheep and goats may be smaller and less pronounced than those in cattle)
Day 4	<p data-bbox="450 220 1727 256">Considerable fibrin deposition has occurred, and regrowth of epithelium is evident at the periphery of the lesion</p> 

Day of clinical disease	Appearance of lesion (note: lesions in sheep and goats may be smaller and less pronounced than those in cattle)
Day 7	<p data-bbox="450 220 1626 256">Extensive scar tissue formation and healing have occurred; some fibrin deposition is usually still present</p> 

Day of clinical disease	Appearance of lesion (note: lesions in sheep and goats may be smaller and less pronounced than those in cattle)
Day 10	<p data-bbox="450 225 1727 252">By day 10, the lesion is likely to have healed, although the scar will be clearly visible as a paler area of epithelium</p> 

In pigs, ageing is best based on coronary band lesions, as follows:

- If the lesion is still on the coronary band, it is unlikely to be more than about 1 week old.
- It takes 7 days for the lesions to mature and new horn growth to begin.
- Examining all eight cleaned claws on each of several pigs for lesions, measure the distance from the coronary band to the lesion. An estimate of the time since the disease was introduced can be made by allowing 2 mm per week in weaners and 1 mm per week in adult pigs.

In sheep and goats, foot lesions tend to be less severe than in cattle. They are more commonly found on the coronary band rather than between the claws. In lesions more than 1 week old, a line may be visible along the hoof wall as a result of coronary band scarring. The distance from the coronary band to the line can give an estimate of the age of the lesions, although it is difficult to be accurate (Dekker & Moonen 2005).

# Appendix 4 Vaccination strategies

## Introduction

Australia's response policy for foot-and-mouth disease (FMD) is for containment and eradication as rapidly as possible to minimise the impacts. Vaccination may be considered if the disease spreads beyond the limit of available resources to contain it, to protect areas of high animal concentrations, and to limit infection and minimise virus excretion.

FMD vaccines will protect animals against clinical disease. Although vaccination may not entirely prevent infection, effective vaccines reduce susceptibility to infection. If infection does occur, vaccination reduces the amount of virus shed into the environment. These two factors mean that vaccination may be a valuable tool to assist with eradication of FMD in Australia under some circumstances.

Biosecurity practised by all field teams is critical to the success of a vaccination program.

Vaccination can be used in three broad ways: protective, suppressive and mass (blanket) vaccination.

Also refer to the relevant nationally agreed standard operating procedures (NASOPs<sup>73</sup>), including:

- NASOP 1: Personal decontamination — entry and exit procedures
- NASOP 14: Control of foot and mouth disease vaccine at a designated vaccine centre
- NASOP 16: Assessing and inspecting a property prior to administration of foot and mouth disease vaccine
- NASOP 17: Vaccinating livestock on a property for foot and mouth disease
- NASOP 24: Ordering of foot and mouth disease vaccine and distribution to states and territories.

## Protective vaccination

Protective vaccination involves vaccination of particular groups of animals in an area to protect them from clinical disease or infection. Vaccination would generally be undertaken outside the known infected area (i.e. restricted area (RA)) and in advance of exposure. Protective vaccination can be considered further in terms of how it is applied: ring, targeted or buffer vaccination.

### Ring vaccination

Ring vaccination builds a ring of immune animals around a focus of infection to prevent further outward spread of the disease. The width of the 'ring' depends on the likely distance that the virus will move. It is an appropriate technique when premises adjacent to, or close to, a focus of infection are considered at risk of becoming infected. It is most effective in reducing the size of outbreaks when used early, and when the disease is spreading rapidly. Vaccination teams would normally begin working from the outer edge of the ring inwards to reduce the risk of spreading infection.

### Targeted vaccination

With targeted vaccination, selected groups or individuals are vaccinated to protect them. This particularly applies to valuable commercial animals (e.g. high-value genetic stock), or rare or valuable animals or herds

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<sup>73</sup> <https://animalhealthaustralia.com.au/nationally-agreed-standard-operating-procedures/>

(e.g. zoo animals). Alternatively, it might be considered to protect high-risk enterprises, such as feedlots, large dairies or large piggeries. Because of the large numbers of animals in close contact in these enterprises, they have the potential to rapidly amplify and excrete FMD virus. Even where these enterprises are not directly involved in the outbreak, they may be a risk because of their proximity to a source of infection. If they were to become infected, they could significantly increase the response effort.

### **Buffer vaccination**

Buffer vaccination is undertaken to create a barrier of immune stock between a heavily infected zone and an area that is free from disease. Animals in a 'band' of properties along the notional border between the two areas are vaccinated to create a buffer population. Vaccination teams would normally begin working from the outer edge of the ring inwards to reduce the risk of spreading infection.

### **Suppressive vaccination**

Suppressive vaccination is the vaccination of a selected group of animals at risk from an outbreak, to control the spread of FMD within and out of an area that is already infected. Vaccination is carried out within the known infected area where it is considered that there is an urgent need to reduce the amount of virus circulating and hence the risk of spread within and beyond the area. It reduces the amount of FMD virus circulating in the area because vaccinated animals, if infected, excrete substantially less virus than fully susceptible animals (Sellers et al 1977). Afterwards, all vaccinated animals may either be removed, or tested using DIVA (differentiating infected from vaccinated animals) technology to establish which herds have not been infected. Uninfected herds may be retained in the population, while infected herds are removed. The post-vaccination strategy will depend on the extent of disease spread during the outbreak and the availability of resources.

Suppressive vaccination is used where there is a recognised risk of escalation of the outbreak, to prevent spread within and beyond the RA. It may be indicated when:

- there is a high density of animals (especially pigs and feedlots)
- the capacity to cull and dispose of carcasses of culled animals within a short period has been overwhelmed (e.g. in feedlots)
- infrastructure is poor, human resources are inadequate or stamping out is delayed.

Suppressive vaccination may have a role where stamping out is planned but is logistically or politically difficult to implement. Vaccination could reduce the risk associated with delayed destruction. Slaughter of vaccinated animals can then be carried out in a progressive, orderly manner. In 2001, the Netherlands used a suppressive vaccination strategy to address logistical problems associated with culling and disposal of animals in infected areas.

### **Mass (blanket) vaccination**

Mass vaccination is vaccination of large numbers of animals over a wide area to protect them from infection and/or disease. It would generally be used where FMD was widespread and not readily containable using other measures. At least initially, the disease would be considered endemic, and a longer-term control program would be required to achieve eradication.

## **Initial assessment — a role for vaccination?**

The key issue in choosing the preferred strategy for managing an FMD outbreak is the extent to which the disease can be controlled with available resources. This will largely be determined by where the outbreak has occurred, the time since the disease was first introduced, and the extent to which the disease has spread across and within industry sectors. Eradication by stamping out may be feasible if the disease was introduced relatively recently and occurs on circumscribed properties within a single compartment. In contrast, containment and control may be more difficult for an outbreak in a high-density livestock production area where there is already evidence of spread across and between different industry sectors.

The criteria in Table A4.1 should be used in assessing whether vaccination is likely to be of benefit in any given outbreak setting.

**Table A4.1 Criteria for assessing benefits of FMD vaccination**

<b>Criterion</b>	<b>For vaccination</b>	<b>Against vaccination</b>
Location	Significant livestock producing area	Isolated farm
Lifetime traceability in place or available for vaccinates	Yes	No
Livestock density (numbers of premises, livestock in immediate vicinity, feedlots, etc)	High	Low
Extent of movements (livestock, product, fomites, wildlife) that have occurred in and around infected premises	Extensive	Limited
Evidence of spread	Evidence of multiple outbreaks involving different industry sectors	Little evidence of spread
Slope of epidemic curve	Rising rapidly	Shallow or slow rise
Likelihood of future spread	Potential to enter multiple properties in different compartments	Extensive spread considered unlikely
Conditions suitable for airborne spread	Yes	No
Spatial distribution of outbreaks	Widespread	Restricted
Suitable vaccine available	Yes	No
Resource availability for stamping out, including timely destruction, disposal and decontamination	Limited	Adequate
Resources for vaccination (adequate vaccine stocks that can be accessed quickly, trained personnel, other logistics)	Adequate	Limited
Industry support for stamping out	Low	High
Public reaction to stamping-out policy	Opposed	Supportive
Market acceptance of product from vaccinated animals	Supportive	Opposed

### **Vaccination strategy — what strategy to use?**

In addition to deciding whether to use vaccination, it is also necessary to consider how vaccination should be used. This includes both the strategy and the species to be vaccinated. The preferred strategy will depend on a range of factors, including:

- amount of vaccine available relative to the numbers of animals at risk
- resources for vaccination
- density of animals (especially pigs)
- capacity to perform effective stamping out
- risk that the disease will get out of control
- presence of rare or endangered animals

- presence of high-risk enterprises (feedlots, large dairy farms, intensive piggeries)
- industry attitudes
- public and political concerns
- surveillance capacity
- acceptance of DIVA technology in target species by trading partners.

Ring vaccination around the infected area(s) could be considered where there is a risk that the outbreak could rapidly escalate. Where stamping out is not feasible because resources are insufficient or the disease has entered a compartment where further spread is inevitable (because of poor biosecurity), suppressive vaccination should be considered. In a large multifocal outbreak where disease is spreading rapidly, mass vaccination may be necessary to bring the situation under control.

The criteria in Table A4.2 may be used to assist in determining the preferred vaccination strategy. (Note that the criteria do not indicate which species would be vaccinated.)

**Table A4.2 Criteria for determining FMD vaccination strategy**

<b>Criterion</b>	<b>Protective ring vaccination</b>	<b>Targeted vaccination</b>	<b>Suppressive vaccination</b>	<b>Mass vaccination</b>
Vaccine availability	Limited	Limited	Limited	Ample
Resources to maintain effective stamping out	Adequate, but escalation possible	Adequate, but protection of selected animals desirable	Inadequate	Inadequate
Short-term capacity to cull animals and dispose of carcasses overwhelmed	No	No	Yes	No
Spatial distribution	Multiple outbreaks with possible future resource problems	Limited or multiple outbreaks	Multiple outbreaks with current resourcing problems	Multifocal or multijurisdictional and out of control
Species at risk	Predominantly ruminants	Predominantly ruminants	Significant numbers of pigs	Various
Rare or endangered animals at risk	No	Yes	No	No
Regional characteristics	High-density, high-value livestock	High-value (rare or endangered) animals, high-risk enterprises	High-density livestock	Various
Species to vaccinate	Ruminants only	Various	All susceptible species	Various

## Appendix 5 Behaviour of foot-and-mouth disease virus in wild (including feral) animals overseas

Caution is needed when considering overseas information on the behaviour of foot-and-mouth disease (FMD) virus in Australian wild (including feral) animals, and whether feral animals play an epidemiological role in disease spread within and between domestic and feral animal populations.

With the exception of transmission of the SAT serotypes of FMD virus from African buffalo to cattle (Thomson et al 2003), neither recurrence of FMD in carriers nor transmission from wild animal carriers has been demonstrated, despite a considerable amount of research. Important contributing factors with respect to the potential for transmission from wild animals are the FMD virus serotype, the population dynamics of the species concerned (including population size, distribution, density, movement and breeding season), contact with susceptible species of domestic livestock, and the introduction of new and susceptible members (Thomson et al 2003). This was supported by a European Food Safety Authority (EFSA) epidemiological model-based study (Lange 2012) that demonstrated that, in the Thrace region of southeastern Europe, the role of wildlife in the spread of infection is variable. The study found that deer did not influence the spread of FMD virus in wildlife and did not spread infection to other species. Wild boar, however, were demonstrated to spread infection to other species under certain conditions, but wildlife populations were not able to maintain the infection beyond the primary epidemic wave. The study noted that there is a strong temperature dependence for FMD virus viability in the environment and seasonal patterns of host reproduction, which influence the chance of virus fade-out from wildlife populations. Contaminated environments are assumed to be the predominant route of transmission between host species and between groups of social hosts. Habitat suitability and host abundance also influence disease spread.

EFSA (2012) concluded that epidemiological observations, published literature and modelling (Lange 2012) support the conclusion that the wildlife population in the Thrace region is not able to maintain FMD in the absence of FMD virus infection in the domestic host population.

EFSA (2012) also concluded that transmission from wildlife to domestic animals can occur, so wildlife can theoretically play some role in the spread of FMD. This conclusion built on work by Mohamed et al (2011), who showed that serotype A of FMD virus could be transmitted from domestic pigs to feral pigs and vice versa under experimental conditions. However, the experimental evidence does not prove the potential for virus transmission in a natural setting, where the prevalence of disease and proximity of infected animals may be much lower.

The then state chief veterinary officers Kevin Dunn and Hugh Millar undertook a study tour to Uruguay in the early 2000s. One of the findings of that tour was that Uruguay was able to eradicate FMD by controlling the disease in domestic livestock only. No control was undertaken in feral pig populations.

# Glossary

## Terms and definitions

### Standard AUSVETPLAN terms

For definitions of standard AUSVETPLAN terms, see the **AUSVETPLAN Glossary**.

### Manual-specific terms

Term	Definition
Biological products	Reagents of biological origin (e.g. sera, hormones) for therapeutic use in the diagnosis or treatment of certain diseases.
<i>Bos indicus</i> cattle breeds	See Zebu (cattle)
<i>Bos taurus</i> cattle breeds	European breeds of cattle, including Friesian, Hereford, Jersey, shorthorn.
Carrier	A ruminant in which FMD virus can be intermittently found in the oropharyngeal area for more than 28 days after infection, often without the animal displaying clinical disease. The role of carrier animals other than African buffalo in the ongoing transmission of FMD virus has not been demonstrated.
Confidence	A measure of reliability. For proof-of-freedom surveillance, confidence refers to the probability of detecting infection in the population if it is present at or above a specified level (the design prevalence).
Coronet (coronary band)	Band around the top of the hoof.
Design prevalence	For proof-of-freedom surveillance, the minimum proportion of infected/exposed animals or farms in the population that the surveillance system is designed to detect with a certain level of statistical confidence.
Export depot	A temporary facility used to assemble, hold, load or unload livestock destined for export from Australia.
Laminitis	Inflammation of the sensitive laminae of the hoof.
Milk and milk products	Includes (from all FMD-susceptible species): <ul style="list-style-type: none"><li>• raw milk</li><li>• milk and other dairy products for human consumption or use</li><li>• milk and other dairy products for human consumption or use that are diverted to animals — for example, surplus milk or milk past its expiry date</li><li>• bathing milk and other beauty products containing dairy products</li><li>• production waste, including washings and wastewater from farms, processing premises and retail premises that are contaminated with dairy products</li><li>• pet milk and manufactured unpelleted stock feed, including milk replacer for calves and lambs</li></ul>

Term	Definition
	<ul style="list-style-type: none"> <li>• pharmaceuticals and other products containing dairy products intended for use in animals, such as extenders used in artificial breeding.</li> </ul>
Plume (virus)	A dense aerosol of virus particles capable of moving over large distances on air currents.
Scales operations	<p>Livestock (predominantly cattle) that are purchased based on a weight and grade system. Fixed (or depot) scale operations are locations where producers bring their cattle to be assessed and purchased by the operator.</p> <p>Mobile scale operators visit farms, and assess and purchase cattle on the farm on which the cattle reside, typically on a weight and grade basis.</p> <p>Mobile scale operators play an important role in the bobby calf supply chain, as the majority of calves are picked up on farm and then delivered direct to the abattoir for processing.</p>
TCID <sub>50</sub>	Tissue culture infectious dose — a measure of virus concentration or dose. Serial dilutions of virus are added to susceptible cells in culture. The dilution of virus at which half the cultures are infected is the TCID <sub>50</sub> .
Vesicular disease	Any disease in which intact, ruptured or healing blisters, papules or ulcers may be evident on skin or mucosal surfaces.
Veterinary authority	According to the WOAH <i>Terrestrial animal health code</i> , the veterinary authority is a country's government authority, comprising veterinarians, other professionals and paraprofessionals, having the responsibility and competence for ensuring or supervising the implementation of animal health and welfare measures, international veterinary certification, and other standards and recommendations in the Terrestrial Code in the whole territory. In Australia, the veterinary authority is the Australian Chief Veterinary Officer or the Australian Government Department of Agriculture, Fisheries and Forestry.
Zebu (cattle)	Bovine animals ( <i>Bos indicus</i> ) with a characteristic large hump over the shoulders. Widely distributed in India, China and eastern Africa, and used for crossbreeding in Africa and northern parts of Australia.

## Abbreviations

### Standard AUSVETPLAN abbreviations

For standard AUSVETPLAN abbreviations, see the **AUSVETPLAN Glossary**.

### Manual-specific abbreviations

Abbreviation	Full title
DIVA	differentiating infected from vaccinated animals
EUFMD	European Commission for the Control of Foot-and-Mouth Disease
FMD	foot-and-mouth disease
NLIS	National Livestock Identification System
NVD	National Vendor Declaration
UK	United Kingdom

## References

- Abbas AM, Al-Amery MAY, Al-Monsawy AYJ & Gati JA (2012). Heat-intolerance syndrome subsequent foot-and-mouth disease in cattle; ThiQar — Iraq. *Proceedings of the Eleventh Veterinary Scientific Conference*, 286–292.
- Abd El Wahed A, El-Deeb, A, El-Tholoth M, Abd El Kader H, Ahmed A, Hassan S, Hoffman B, Haas B, Shalaby MA, Hufert FT & Weidmann M (2013). A portable reverse transcription recombinase polymerase amplification assay for rapid detection of foot-and-mouth disease virus. *PLoS ONE* 8(8):e71642.
- Alexandersen S (2005). *Virus inactivation kinetics session of the Research Group of the Standing Technical Committee of EuFMD*, Greifswald Insel-Riems, Germany, Appendix 23, 192–200.
- Alexandersen S, Zhang Z & Donaldson AI (2002). Aspects of the persistence of foot-and-mouth disease virus in animals: the carrier problem. *Microbes and Infection* 4(10):1099–1110.
- Alexandersen S, Quan M, Murphy C, Knight J & Zhang Z (2003). Studies of quantitative parameters of virus excretion and transmission in pigs and cattle experimentally infected with foot-and-mouth disease virus. *Journal of Comparative Pathology* 129(4):268–282.
- Alexandersen S, Wernery U, Nagy P, Frederiksen T & Normann P (2008). Dromedaries (*Camelus dromedarius*) are of low susceptibility to inoculation with foot-and-mouth disease virus serotype O. *Journal of Comparative Pathology* 139(4):187–193.
- APHIS (Animal and Plant Health Inspection Service) (1980). Survival of foot-and-mouth disease virus. In: *Foot-and-mouth disease: guidelines for eradication*, United States Department of Agriculture, 129–130.
- Arkwright JA & Burbury M (1925). Observations on foot-and-mouth disease. Section I. Transmission of foot-and-mouth disease to rodents. *Journal of Comparative Pathology and Therapeutics* 38:231–238.
- Armstrong R, Davie J & Hedge RS (1967). Foot and mouth disease in man. *British Medical Journal* 4:529–530.
- Arzt JP (2010). The early pathogenesis of foot-and-mouth disease in cattle after aerosol inoculation: identification of the nasopharynx as the primary site of infection. *Veterinary Pathology* 47(6):1048–1063.
- Auty H, Mellor D, Gunn G & Boden LA (2019). The risk of foot and mouth disease transmission posed by public access to the countryside during an outbreak. *Frontiers in Veterinary Science* 6:381.
- Bachrach HL (1968). Foot-and-mouth disease. *Annual Reviews of Microbiology* 22:201–244.
- Barnett PV & Carabin H (2002). A review of emergency foot-and-mouth disease (FMD) vaccines. *Vaccine* 20:1505–1514.
- Bauer K & Eissner G (1972). Persistence and disinfection of foot-and-mouth disease (FMD) virus in liquid manure from storage tanks. *Berliner und Munchener Tierarztliche Wochenschrift* 90:1–5.
- Bestbier M (2016). *Risk assessment: transmission of foot and mouth disease virus in milk droplet aerosol generated during milk tanker collection*, Ministry for Primary Industries (New Zealand), Wellington.
- Blackwell JH (1976). Survival of foot-and-mouth disease virus in cheese. *Journal of Dairy Science* 59:1574–1579.
- Blackwell JH & Hyde JL (1976). Effect of heat on foot-and-mouth disease virus (FMDV) in the components of milk from FMDV-infected cows. *Journal of Hygiene* 77:77–83.

- Bohm HO (1975). Disinfection of intestines contaminated with foot-and-mouth disease virus. *Bulletin de l'Office International des Epizooties* 83:133–136.
- Bohm HO & Krebs H (1974). Detection of foot-and-mouth disease virus in organs of infected sheep after slaughter. *Berliner und Munchener Tierarztliche Wochenschrift* 87:410–412.
- Buetre BW, Wicks S, Kruger H, Millist N, Yainshet A, Garner G, Duncan A, Abdalla A, Trestrail C, Hatt M, Thompson L-J & Symes M (2013). *Potential socio-economic impacts of an outbreak of foot-and-mouth disease in Australia*, Australian Bureau of Agricultural Research Economics and Sciences, Canberra.
- Bunn CM (2013). *Foot and mouth disease (FMD) risks relating to wildlife: scope, gap analysis and future priorities*, Australian Wildlife Health Network, Sydney, 21–23.
- Bunn CM, Garner MG & Cannon RM (1998). The 1872 outbreak of foot-and-mouth disease in Australia: why didn't it become established? *Australian Veterinary Journal* 76(4):262–269.
- Byeong-Yong L (2015). *Outbreaks and control strategy of FMD in Korea*, Ministry for Food, Agriculture, Food and Rural Affairs, report to Global Framework for the Progressive Control of Transboundary Animal Diseases 4th Coordination Committee Meeting, Tokyo, 9–10 June 2015.
- Callis JJ, McKercher PD & Shahan MS (1980). Foot-and-mouth disease. In: *Diseases of swine*, Dunne HW & Leman AD (eds), Iowa State University Press, Ames, Iowa, 325–345.
- Capel-Edwards M (1970). Foot-and-mouth disease in the brown rat. *Journal of Comparative Pathology* 80:543–548.
- Çokçalışkan C, Türkoğlu T, Uzunlu E, Sareyyüpoğlu B, Hanci I, Ipek A, Arslan A, Babak A, Ildeniz G & Gülyaz V (2017). Influence of vaccine potency and booster administration of foot-and-mouth disease vaccines on the antibody response in calves with maternal antibodies. *Journal of Veterinary Science* 18(Suppl 1):315–322.
- Condy JB, Hedger RS, Hamblin C & Barnett IT (1985). The duration of the foot-and-mouth disease virus carrier state in African buffalo (i) in the individual animal and (ii) in a free-living herd. *Comparative Immunology, Microbiology and Infectious Diseases* 8:259–265.
- Cottral GE (1960). The survival of foot-and-mouth disease virus in cured and uncured meat. *American Journal of Veterinary Research* 21:288–297.
- Cottral GE (1969). Persistence of foot-and-mouth disease virus in animals, their products and the environment. *Bulletin de l'Office International des Epizooties* 71:549–568.
- Cottral GE, Gailiunas P & Cox BF (1968). Foot-and-mouth disease virus in semen of bulls and its transmission by artificial insemination. *Archiv für die gesamte Virusforschung* 23:362–377.
- DEFRA (Department for Environment, Food and Rural Affairs) (2005). *Foot and mouth disease ageing of lesions*, DEFRA, London,  
<https://webarchive.nationalarchives.gov.uk/ukgwa/20130402151656/http://archive.defra.gov.uk/foodfarm/farmanimal/diseases/atoz/fmd/documents/ageing-lesions.pdf>.
- DEFRA (Department for Environment, Food and Rural Affairs) (2006). *Summary profile for foot and mouth disease*, DEFRA, London,  
<http://archive.defra.gov.uk/foodfarm/farmanimal/diseases/vetsurveillance/profiles/documents/sp-fmd.pdf>.
- Dekker A & Moonen P (2005). Linear hoof defects in sheep infected with foot-and-mouth disease. *Veterinary Record* 156(18):572–575.

- Dhennin L, Frouin A, Gicquel B, Bidard JP & Labie J (1980a). Risk of disseminating FMD virus by uncooked meat products. *Bulletin de l'Academie Veterinaire de France* 53:315–322.
- Dhennin L, Frouin A, Gicquel B, Bidard JP & Labie J (1980b). Risk of disseminating FMD virus by meat products: survival of FMD virus in dry sausage. *Bulletin de l'Academie Veterinaire de France* 53:349–355.
- Donaldson AI (1972). The influence of relative humidity on the aerosol stability of different strains of foot and mouth disease virus suspended in saliva. *Journal of General Virology* 15:25–33.
- Donaldson AI (1983). Quantitative data on airborne FMD virus; its production, carriage and deposition. *Philosophical Transactions of the Royal Society, London (Series B)* 302:529–534.
- Donaldson AI, Herniman KAJ, Parker J & Sellers RF (1970). Further investigations on the airborne excretion of foot-and-mouth disease virus. *Journal of Hygiene (Cambridge)* 69:557–564.
- Donaldson AI, Gloster J, Harvey LD & Deans DH (1982). Use of prediction models to forecast and analyse airborne spread during the foot-and-mouth disease outbreaks in Brittany, Jersey and the Isle of Wight in 1981. *Veterinary Record* 110(3):53–57.
- East IJ, Roche SE, Wicks RM, de Witte K & Garner MG (2014). Options for managing animal welfare on intensive pig farms confined by movement restrictions during an outbreak of foot and mouth disease. *Preventive Veterinary Medicine* 117(3–4):533–541.
- EFSA (European Food Safety Authority) (2012). Scientific opinion on foot-and-mouth disease in Thrace. *EFSA Journal* 10(4):2635, <https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2012.2635>.
- Elnekave E, Dekker A, Eble P, van Hemert-Kluitenberg F, Gelman B, Storm N & Klement E (2016). The serological response against foot and mouth disease virus elicited by repeated vaccination of dairy cattle. *Vaccine* 34(41):4920–4926.
- EUFMD (European Commission for the Control of Foot-and-Mouth Disease) (nd). *A field guide to estimating the age of foot-and-mouth disease lesions*, EUFMD, [www.fao.org/fileadmin/user\\_upload/eufmd/docs/training/EnglLesionageing.pdf](http://www.fao.org/fileadmin/user_upload/eufmd/docs/training/EnglLesionageing.pdf)
- FAO (Food and Agriculture Organization of the United Nations) (2017). *Monthly report: foot-and-mouth disease situation*, FAO, Rome, [www.fao.org/fileadmin/user\\_upload/eufmd/docs/FMD\\_monthly\\_reports/2017/June2017.pdf](http://www.fao.org/fileadmin/user_upload/eufmd/docs/FMD_monthly_reports/2017/June2017.pdf).
- Fleming P (2004). *Relationships between feral goats (Capra hircus) and domestic sheep (Ovis aries) with reference to exotic disease transmission*, PhD thesis, University of Canberra, Canberra.
- Gailiunas P & Cottral GE (1967). Survival of foot-and-mouth disease virus in bovine hides. *American Journal of Veterinary Research* 28:1047–1053.
- Gailiunas P, Cottral GE & Scott FW (1969). Survival of foot-and-mouth disease virus on meat packaging materials. *Proceedings of the United States Livestock Sanitary Association* 73:75–85.
- Garner MG & Cannon RM (1995). *Potential for wind-borne spread of foot and mouth disease virus in Australia*, report prepared for the Australian Meat Research Corporation, Australian Government Publishing Service, Canberra.
- Ghanem M & Abdel-Hamid OM (2010). Clinical, haematological and biochemical alterations in heat intolerance (panting) syndrome in Egyptian cattle following natural foot-and-mouth disease (FMD). *Tropical Animal Health Production* 42(6):1167–1173.

- Gibbens JC, Sharpe CE, Wilesmith JW, Mansley LM, Michalopoulou E, Ryan JBM & Hudson M (2001). Descriptive epidemiology of the 2001 foot-and-mouth disease epidemic in Great Britain: the first five months. *Veterinary Record* 149:729–743.
- Gloster J, Doel C, Gubbins S & Paton DJ (2008). Foot-and-mouth disease: measurements of aerosol emission from pigs as a function of virus strain and initial dose. *Veterinary Journal* 177:374–380.
- Hardham JM, Krug P, Pacheco JM, Thompson J, Dominowski P, Moulin V, Gay CG, Rodriguez LL & Rieder E (2020). Novel foot-and-mouth disease vaccine platform: formulations for safe and DIVA-compatible FMD vaccines with improved potency. *Frontiers in Veterinary Science* 7:554305.
- Hayama Y, Muroga N, Nishida T, Kobayashi S & Tsutsui T (2012). Risk factors for local spread of foot-and-mouth disease, 2010 epidemic in Japan. *Research in Veterinary Science* 93:631–635.
- Hernandez-Divers S, Quse V, May JA, de Thoisy B, Thijl Vanstreels RE, Blanco Marquez PA & Lira Torres I (2007). *Tapir field veterinary manual*, Tapir Specialist Group, Brazil.
- Hone S, Gooday P, Hafi A & Greenville J (2022). *Discount rates and risk in the economic analysis of agricultural projects*, ABARES Working Paper 22.02, Australian Bureau of Agricultural Research Economics and Sciences, Canberra.
- Jamal SM & Belsham GJ (2013). Foot-and-mouth disease: past, present and future. *Veterinary Research* 44:116.
- Kaleta EF (2002). Foot-and-mouth disease: susceptibility of domestic poultry and free-living birds to infection and to disease — a review of the historical and current literature concerning the role of birds in spread of foot-and-mouth disease viruses. *Deutsche Tierärztliche Wochenschrift* 109(9):391–399.
- Kitching R (2002). Clinical variation in foot and mouth disease: cattle. *Revue Scientifique et Technique (Office International des Epizooties)* 21(3):499–504.
- Kitching RP & Alexandersen S (2002). Clinical variation in foot and mouth disease: pigs. *Revue Scientifique et Technique (Office International des Epizooties)* 21(3):513–518.
- Kitching RP & Hughes GJ (2002). Clinical variation in foot and mouth disease: sheep and goats. *Revue Scientifique et Technique (Office International des Epizooties)* 21(3):505–512.
- Kitching RP & Mackay DK (1995). Foot and mouth disease. *State Veterinary Journal* 5(3):4–8.
- Kompas T, Ha PV, Nguyen HTM, East I, Roche S & Garner G (2017). Optimal surveillance against foot-and-mouth disease: the case of bulk milk testing in Australia. *Australian Journal of Agricultural and Resource Economics* 61(4):515–538.
- Krug PW, Larson CR, Eslami AC & Rodriguez LL (2012). Disinfection of foot-and-mouth disease and African swine fever viruses with citric acid and sodium hypochlorite on birch wood carriers. *Veterinary Microbiology* 156:96–101.
- Lange M (2012). *Spatial spread and maintenance of foot-and-mouth disease virus infections in wildlife populations of Thrace region applying epidemiological modelling*, scientific report submitted to EFSA, <https://efsa.onlinelibrary.wiley.com/doi/pdf/10.2903/sp.efsa.2012.EN-264>.
- Larska M, Wernery U, Kinne J, Schuster R, Alexandersen G & Alexandersen S (2009). Differences in the susceptibility of dromedary and bactrian camels to foot-and-mouth disease virus. *Epidemiology and Infection* 137(4):549–554.

- Maes D, Nauwynck H, Rijsselaere T, Mateusen B, Vyt P, de Kruif A & Van Soom A (2008). Diseases in swine transmitted by artificial insemination: an overview. *Theriogenology* 70(8):1337–1345.
- Mahnel M, Orris K & Herlyn M (1977). Stability in drinking and surface water of nine virus species of various general. *Zentralblatt für Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene, Erste Abteilung Originale* 16B:64–84.
- Maree FF, Blignaut B, de Beer TAP & Rieder E (2013). Analysis of SAT type foot-and-mouth disease virus capsid proteins and the identification of putative amino acid residues affecting virus stability. *PLoS ONE* 8(5):e61612.
- Matthews K (2011). *A review of Australia's preparedness for the threat of foot-and-mouth disease*, Australian Government Department of Agriculture, Fisheries and Forestry, Canberra.
- McCull KA, Westbury HA, Kitching RP & Lewis VM (1995). The persistence of foot-and-mouth disease virus on wool. *Australian Veterinary Journal* 72(8):286–292.
- McKercher PD & Callis JJ (1983). Residual viruses in fresh and cured meat. In: *Proceedings of annual meeting*, Livestock Conservation Institute, Madison, 143–146.
- McVicar J, Eisner R, Johnson L & Pursel V (1978). Foot-and-mouth disease and swine vesicular disease viruses in boar semen. In: *Proceedings of the 81st annual meeting of the American Animal Health Association*, 221–230.
- Mebus CA, House C, Gonzalvo FR, Pineda JM, Tapiador J, Pire JJ, Bergada J, Yedloutschnig RJ, Sahu S, Becerra V & Sanchez-Vizcaino JM (1993). Survival of foot-and-mouth disease, African swine fever, and hog cholera viruses in Spanish serrano cured hams and Iberian cured hams, shoulders and loins. *Food Microbiology* 10(2):133–143.
- Meyer A, Zamir L, Ben Yair Gilboa A, Gelman B, Pfeiffer DU & Vergne T (2017). Quantitative assessment of the risk of release of foot-and-mouth disease virus via export of bull semen from Israel. *Risk Analysis* 37(12):2350–2359.
- Mohamed F, Swafford S, Petrowski H, Bracht A, Schmit B, Fabian A, Pacheco JM, Hartwig E, Berninger M, Carrillo C, Mayr G, Moran K, Kavanaugh D, Leibrecht H, White W & Metwall S (2011). Foot-and-mouth disease in feral swine: susceptibility and transmission. *Transboundary and Emerging Diseases* 58:358–371.
- Morgan I (1993). *Spread of foot-and-mouth disease*, review prepared for the Australian Meat Research Corporation, Sydney.
- Muroga N, Hayama Y, Yamamoto T, Kurogi A, Tsuda T & Tsutsui T (2012). The 2010 foot-and-mouth disease epidemic in Japan. *Veterinary Medicine and Science* 74(4):399–404.
- Nelson N, Paton DJ, Gubbins S, Colenutt C, Brown E, Hodgson S & Gonzales JL (2017). Predicting the ability of preclinical diagnosis to improve control of farm-to-farm foot-and-mouth disease transmission in cattle. *Journal of Clinical Microbiology* 55(6):1671–1681.
- Neumann EJ, Ramirez A & Schwartz KJ (eds) (2017). Foot-and-mouth disease (FMD). In: *Swine disease manual*, 4th edn, American Association of Swine Veterinarians, Perry, Iowa, <https://vetmed.iastate.edu/vdpam/FSVD/swine/index-diseases/foot-mouth-disease>.
- Officer KN, Lan NT, Wicker L, Hoa, NT, Weegenaar A, Robinson J, Ryoji Y & Loukopoulos P (2014). Foot-and-mouth disease in Asiatic black bears (*Ursus thibetanus*). *Journal of Veterinary Diagnostic Investigation* 26(5):705–713.

- OIE (World Organisation for Animal Health) (2013). *Foot and mouth disease*, technical disease card, OIE, Paris, [www.woah.org/app/uploads/2021/09/foot-and-mouth-disease.pdf](http://www.woah.org/app/uploads/2021/09/foot-and-mouth-disease.pdf).
- Pacheco JM, Brito B, Hartwig E, Smoliga GR, Perez A, Arzt J & Rodriguez LL (2015). Early detection of foot-and-mouth disease virus from infected cattle using a dry filter air sampling system. *Transboundary and Emerging Diseases* 64(2):564–573.
- Paton DJ, Sinclair M & Rodríguez R (2009). Qualitative assessment of the commodity risk for spread of foot-and-mouth disease associated with international trade in deboned beef. *Transboundary and Emerging Diseases* 57(3):115–134.
- Productivity Commission (2002). *Impact of a foot and mouth disease outbreak on Australia*, research report, Ausinfo, Canberra.
- Ramsay EC & Zainuddin Z-Z (1993). Infectious diseases of the rhinoceros and tapir. In: *Zoo and wild animal medicine: current therapy*, Fowler ME (ed), WB Saunders, Philadelphia, 459–465.
- Ranjan R, Biswal JK, Subramaniam S, Singh KP, Stenfeldt C, Rodriguez LL, Pattnaik B & Arzt J (2016). Foot-and-mouth disease virus-associated abortion and vertical transmission following acute infection in cattle under natural conditions. *PLoS ONE* 11(12):e0167163.
- Reid SM, Parida S, King DP, Hutchings GH, Shaw AE, Ferris NP, Zhang Z, Hillerton E & Paton DJ (2005). Utility of automated real-time RT-PCR for the detection of foot-and-mouth disease virus excreted in milk. *Veterinary Research* 37:121–132.
- Rozov AA & Andryunin YI (1972). Survival of foot-and-mouth disease virus in liquid manure and its disinfection. *Problemy Veterinarnoi Sanitarii* 43:247–250.
- Salje HC, Cummings DAT & Lessler J (2016). Estimating infectious disease transmission distances using the overall distribution of cases. *Epidemics* 17:10–18.
- Salwa A & Gaber AS (2007). Inactivation of foot and mouth disease virus in milk and milk products. *Milchwissenschaft* 62(1):3–5.
- Scott Williams Consulting & Herd Health (2017). Persistence of disease agents in carcasses and animal products, version 3: March 2017, report for Animal Health Australia, Canberra, [www.animalhealthaustralia.com.au/wp-content/uploads/Persistence\\_of\\_Disease\\_Agents\\_Report\\_Web\\_20170413.pdf](http://www.animalhealthaustralia.com.au/wp-content/uploads/Persistence_of_Disease_Agents_Report_Web_20170413.pdf)
- Sellers RF, Donaldson AI & Herniman KAJ (1970). Inhalation, persistence and dispersal of foot-and-mouth disease virus by man. *Journal of Hygiene (Cambridge)* 68:565–573.
- Sellers RF, Herniman KA & Gumm ID (1977). The airborne dispersal of foot-and-mouth disease virus from vaccinated and recovered pigs, cattle and sheep after exposure to infection. *Research in Veterinary Science* 23:70–75.
- Snowdon WA (1968). The susceptibility of some Australian fauna to infection with foot-and-mouth disease virus. *Australian Journal of Experimental and Medical Science* 46:667–687.
- Spickler AR (2014). *Foot and mouth disease*, technical factsheet, Centre for Food Security and Public Health, Ames, Iowa, [www.cfsph.iastate.edu/DiseaseInfo/factsheets.php](http://www.cfsph.iastate.edu/DiseaseInfo/factsheets.php).
- Stenfeldt C & Arzt J (2020). The carrier conundrum: a review of recent advances and persistent gaps regarding the carrier state of foot-and-mouth disease virus. *Pathogens* 9(3):167.

- Stenfeldt CP, Pacheco JM, Rodriguez LL & Arzt J (2014). Early events in the pathogenesis of foot-and-mouth disease in pigs: identification of oropharyngeal tonsils as sites of primary and sustained viral replication. *PLoS ONE* 9(9):e106859.
- Sutmoller P, Barteling SS, Olascoaga RC & Sumpston KJ (2003). Control and eradication of foot-and-mouth disease. *Virus Research* 91(1):101–144.
- Thomson GR, Vosloo W & Bastos ADS (2003). Foot and mouth disease in wildlife. *Virus Research* 91:145–161.
- van Rijn PA, Wellenberg GJ, Hakze-van der Honing R, Jacobs L, Moonen PLJM & Feitsma H (2004). Detection of economically important viruses in boar semen by quantitative RealTime PCR™ technology. *Journal of Virological Methods* 120(2):151–160.
- Vosloo W, Morris J, Nguyen T, Kim P, Quach N, Le P, Dang H, Tran H, Vu P, Vo H, Le Q, Mai T, Le Q & Singanallur N (2012). Using ropes to detect foot-and-mouth disease virus infection in pigs. In: *Proceedings of Bi-Annual EUFMD Open Session, 28–31 October 2012, Jerez de la Frontera, Spain*, <http://hdl.handle.net/102.100.100/99047?index=1>.
- Ward MG, Garner G & Cowled BD (2015). Modelling foot-and-mouth disease transmission in a wild pig–domestic cattle ecosystem. *Australian Veterinary Journal* 93:4–12.
- Waters RA, Fowler VL, Armson B, Nelson N, Gloster J, Paton DJ & King DP (2014). Preliminary validation of direct detection of foot-and-mouth disease virus within clinical samples using reverse transcription loop-mediated isothermal amplification coupled with a simple lateral flow device for detection. *PLoS ONE* 9(8):e105630.
- Wijnker JJ, Haas B & Berends BR (2007). Removal of foot-and-mouth disease virus infectivity in salted natural casings by minor adaptation of standardized industrial procedures. *International Journal of Food Microbiology* 115(2):214–219.
- Wijnker JJ, Haas B & Berends BR (2011). Inactivation of foot-and-mouth disease virus in various bovine tissues used for the production of natural sausage casings. *International Journal of Food Microbiology* 153:237–240.
- Wittmann G (1990). Virusträger bei Maul- und Klauenseuche: Übersichtsreferat [Virus carriers in foot-and-mouth disease: review]. *Berliner und Münchener tierärztliche Wochenschrift* 1;103(5):145–150.
- Wright CF, Gloster J, Mazelet L, Paton DJ & Ryan ED (2010). Short-lived carriage of foot-and-mouth disease virus in human nasal cavities after exposure to infected animals. *Veterinary Record* 167(24):928–931.

