There are many different factors that may play a role in the selection of a response strategy or strategies; choosing one strategy, multiple strategies, or modifying strategies as an outbreak unfolds is an important, but complex, decision. However, four of the five traditional response strategies employ FMD vaccine. This document provides a brief overview of emergency vaccination for an FMD response.

Overview of Traditional FMD Response Strategy or Strategies

Strategy or Strategies	Definition of Strategy	Likelihood of Use	Example of Application
Stamping-Out (No Emergency Vaccination)	Depopulation of clinically affected and in-contact susceptible animals.	Possible (if outbreak is contained in jurisdictional areas in which FMD can be readily contained and further dissemination of the virus is unlikely).	Stamping-out Infected Premises.
Stamping-Out Modified with Emergency Vaccination to Kill	Depopulation of clinically affected and in-contact susceptible animals and vaccination of at-risk animals, with subsequent depopulation and disposal of vaccinated animals. Depopulation and disposal of vaccinated animals may be delayed until logistically feasible, as determined by Incident Command and the VS Deputy Administrator (U.S. CVO).	Possible (if outbreak is contained in jurisdictional areas in which FMD can be readily contained and further dissemination of the virus is unlikely).	Stamping-out Infected Premises, emergency vaccination to kill within the selected areas of the Buffer Zone in Containment Vaccination Zones.
Stamping-Out Modified with Emergency Vaccination to Slaughter	Depopulation of clinically affected and in-contact susceptible animals and vaccination of at-risk animals, with subsequent slaughter of vaccinated animals if animals are eligible for slaughter under USDA Food Safety and Inspection Service authority and rules and/or State and Tribal authority and rules.	Highly likely (depending on the type of the FMD outbreak).	Stamping-out Infected Premises; emergency vaccination to slaughter within the Control Area in Containment Vaccination Zones.
Stamping-Out Modified with Emergency Vaccination to Live	Depopulation of clinically affected and in-contact susceptible animals and vaccination of at-risk animals, without subsequent depopulation of vaccinated animals. Vaccinated animals intended for breeding, slaughter, or other purposes live out their useful lives.	Highly likely (depending on the type of the FMD outbreak).	Stamping-out Infected Premises; emergency vaccination to live outside of the Control Area in Protection Vaccination Zones.
Combination of Stamping-Out Modified with Emergency Vaccination to Kill, Slaughter, and Live	Combination of emergency vaccination to kill, slaughter, and live.	Highly likely (depending on the type of the FMD outbreak).	Stamping-out Infected Premises; emergency vaccination to slaughter within the Control Area in Containment Vaccination Zones and emergency vaccination to live outside of the Control Area in Protection Vaccination Zones.
Vaccination to Live (without Stamping-Out)	Vaccination used without depopulation of infected animals or subsequent depopulation or slaughter of vaccinated animals.	Less likely (unlikely to be implemented at start of outbreak).	No stamping-out Infected Premises; Vaccination to live outside of the Control Area in Protection Vaccination Zones.
No Action	FMD would take its course in the affected population; other measures may be implemented to control and contain FMD spread.	Unlikely.	Quarantine and movement control measures; biosecurity measures; cleaning and disinfection measures implemented. No stamping-out and no vaccination.

Factors Influencing the Decision to Use Emergency Vaccination Strategies

Factor or Criterion Supporting the Response Strategy	Strategy				
	Stamping-Out	*Stamping-Out Modified with Emergency Vaccination to Kill*	*Stamping-Out Modified with Emergency Vaccination to Slaughter*	*Stamping-Out Modified with Emergency Vaccination to Live*	*Emergency Vaccination to Live Without Stamping-Out*
Suitable vaccine for FMD outbreak strain	Not available/ feasible	Available	Available	Available	Available
Resources for stamping-out (such as disposal)	Adequate	Adequate	Moderately limited	Limited	Limited
Resources for vaccination (such as diagnostic testing, tracing efforts, and permitting activities)	Limited	Moderately limited	Adequate	Adequate	Adequate
Population density of susceptible animals at high risk of becoming infected	Low	Moderate	High	High	High
Population density of virus amplifying animals	Low	Moderate	Moderate	High	High
Movement of infected animals, products, or fomites out of Control Area	No evidence of extensive movement	Evidence of movement	Evidence of extensive movement	Evidence of extensive movement	Evidence of extensive movement
Origin of outbreak	Known	Known	Unknown	Unknown	Unknown
Location of initial outbreak	Isolated premises	Livestock producing area	Livestock producing area	Livestock producing area	Livestock producing area
Spread of outbreak	Slow	Rapid	Rapid	Rapid	Rapid
Distribution of outbreak	Limited or restricted	Regional	Widespread	Widespread	Widespread
Risk of infection in valuable, rare, endangered, or high-value genetic livestock	High	High	High	Moderate	Low
Likelihood that FMD could become prevalent in feral swine, deer, or other wildlife	High	High	High	Moderate	Low
Public acceptance of stamping-out strategy	Neutral reaction or weak opposition	Neutral reaction or weak opposition	Weak opposition	Strong opposition	Strong opposition
Surveillance, diagnostic, and laboratory resources for serosurveillance after vaccination	Limited	Limited	Limited	Available	Available
Domestic stakeholders' acceptance of regionalization with stamping-out or vaccination to kill	Yes	Yes	No	No	No
Domestic stakeholders' acceptance of regionalization with vaccination to live or vaccination to slaughter	No	No	Yes	Yes	Yes

Factors Influencing the Decision to Use Emergency Vaccination Strategies, continued

Factor or Criterion Supporting the Response Strategy	Strategy				
	Stamping-Out	*Stamping-Out Modified with Emergency Vaccination to Kill*	*Stamping-Out Modified with Emergency Vaccination to Slaughter*	*Stamping-Out Modified with Emergency Vaccination to Live*	*Emergency Vaccination to Live Without Stamping-Out*
Trading partner acceptance of regionalization with stamping-out or vaccination to kill	Accepted	Accepted	Not accepted	Not accepted	Not accepted
Trading partner acceptance of regionalization with vaccination to slaughter or vaccination to live	Not accepted	Not accepted	Accepted	Accepted	Accepted
Assessments and economic analysis of competing control strategies	It is likely that a control strategy with emergency vaccination will lead to significantly higher economic losses, or longer duration of the outbreak	It is likely that a control strategy without emergency vaccination to kill will lead to significantly higher economic losses or longer duration of the outbreak	It is likely that a control strategy without emergency vaccination to slaughter will lead to significantly higher economic losses or longer duration of the outbreak	It is likely that a control strategy without emergency vaccination to live will lead to significantly higher economic losses or longer duration of the outbreak	It is likely that a control strategy with stamping-out will lead to significantly higher economic losses or longer duration of the outbreak

How Will We Decide Which Strategy to Implement?

The selection of a response strategy or strategies will be based on achieving the following goals: To 1) detect, control, and contain FMD in animals as quickly as possible; 2) eradicate FMD using strategies that seek to stabilize animal agriculture, the food supply, and the economy, and protect public health and the environment; and 3) provide science- and risk-based approaches and systems to facilitate continuity of business for non-infected animals and non-contaminated animal products.

The outbreak response strategy (or strategies) is likely to change throughout the outbreak, and may vary according to region, species impacted, or other defining characteristics. There are many different factors that may play a role in the selection of a response strategy, including resources available and known epidemiological information about the outbreak. No single factor will independently dictate a response strategy, or whether an emergency vaccination strategy will be employed.

Vaccine Quantities

How Much Vaccine Will We Need?

The amount of vaccine required in an FMD outbreak will depend on many factors, including (but certainly not limited to) what species are affected, how fast FMD is detected in this country, the location of the FMD outbreak, the rate of FMD transmission, the social and political acceptance of various response strategies, and the response capabilities for depopulation, disposal, disinfection, and/or vaccination.

How Do We Know How Much Vaccine We Need?

There are many different ways to estimate the amount of vaccine that will be required in an FMD outbreak, including approximating from livestock demographics, modeling, and evaluating past outbreaks in other countries. Each of these methods has its pros and cons; estimating the amount of vaccine needed is a difficult task.

Who Is Working on Estimating How much Vaccine We Need?

Many groups inside APHIS Veterinary Services are actively collaborating to assess the amount of vaccine that may be needed. However, good estimates require accurate data about not only the disease agent, but about livestock populations, movements, and premises in the United States.

Information on FMD Vaccines

- There are 7 serotypes (O, A, C, Asia1, SAT-1, SAT-2, SAT-3) and approximately 65 strains of FMD; there is no cross-protection between serotypes and protection between strains varies based on antigenic similarity.
- There are two types of adjuvants:
  - Aluminum hydroxide adjuvanted FMD vaccines: work well in cattle, sheep, goats, but poorly in pigs.
  - Oil-adjuvanted FMD vaccines: use in any species, may have longer duration of immunity, less interference from maternal antibodies, and better shelf-life.
- Non-commercial vaccine banks can be activated in emergencies. The United States participates in the North American FMD Vaccine Bank (NAFMDVB) with Canada and Mexico.
- Vaccine banks typically store concentrated antigens.
  - Banks only store a limited number of serotypes and strains, usually based on risk and current transmission.
  - The concentrated antigens must be finished into complete vaccines in the event of an outbreak.
  - The finished vaccines (from the vaccine antigen concentrate) are high potency vaccines.
- Duration of immunity depends on the type of vaccine used and varies by animal species. No single dose of any FMD vaccine provides "sterilizing immunity" which will prevent all future infections.

Overview of Zones and Premises for Vaccination

Vaccinated Premises

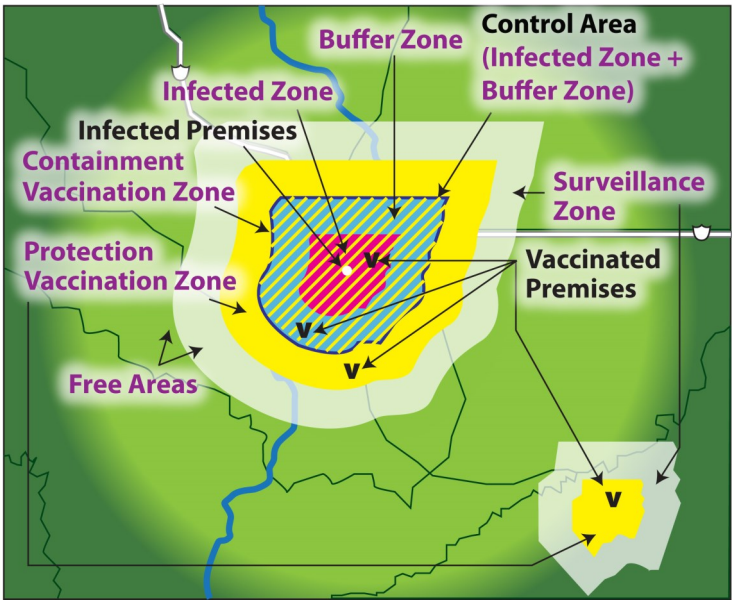
This is a premises where emergency vaccination has been performed. This may be a secondary premises designation. A Vaccinated Premises (VP) may be in either a Containment Vaccination Zone (CVZ) or a Protection Vaccination Zone (PVZ).

Containment Vaccination Zone

A CVZ is typically a zone within the Control Area, and may include the Infected Zone (IZ) or Buffer Zone (BZ), or a part of either the IZ or BZ. A CVZ may be a secondary zone designation.

Protection Vaccination Zone

A PVZ is typically a zone outside of the Control Area. A PVZ may be a secondary zone designation.



World Organization for Animal Health (OIE) Definition of a Protection Zone

A protection zone is established to protect the health status of animals in a free country or free zone, from those in a country or zone of a different animal health status, using measures based on the epidemiology of the disease under consideration to prevent spread of the causative pathogenic agent into a free country or free zone. These measures may include, but are not limited to, vaccination, movement control, and an intensified degree of surveillance.

Vaccination in a Vaccination Zone

Vaccination will occur on a VP. Animals receiving emergency vaccination in either a CVZ or PVZ may be subject to vaccinated animal identification and testing to differentiate between infected and vaccinated animals (DIVA). Typically, a CVZ would be seen with stamping-out modified with emergency vaccination to slaughter; a PVZ would be seen with a stamping-out modified with emergency vaccination to live strategy.

Movement Control for Vaccinated Premises

- VP may be subject to any risk assessments, surveillance, and biosecurity procedures and requirements established for the primary premises designation.
- Animals receiving emergency vaccination on VP may be subject to vaccinated animal identification and DIVA testing.
- Primary premises designations may be used for moving animals and items into, within, or out of a Vaccination Zone.

Movement Control for Vaccination Zones

- Primary zone designations may be used for moving animals and items into, within, or out of a CVZ or a PVZ.
- Movement control into, within, or out of a Control Area from specific premises is summarized in a companion ready reference guide.
- For movement of emergency vaccinated animals, consideration must be given to any national or international standards or conditions for such movement.

Example Incident Command Structure for FMD Emergency Vaccination (from the California Animal Health Emergency Management System; any organizational chart will be based on the requirements of the incident)