MANUAL ON PROCEDURES FOR DISEASE ERADICATION BY STAMPING OUT

Compiled by William A. Geering and Mary-Louise Penrith , Consultants , EMPRES/Infectious Diseases Group, and based on the Destruction of Animals, Disposal Procedures, and Decontamination Operation Procedures Manuals of AUSVETPLAN (The Australian Veterinary Emergency Plan)

(Draft 1)

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PART 3: DECONTAMINATION PROCEDURES

Acknowledgements

This Manual of Procedures for Disease Eradication by Stamping Out is based on the Destruction of Animals, Disposal Procedures, and Decontamination Operation Procedures Manuals of AUSVETPLAN (Second Edition, 1996). AUSVETPLAN is a series of technical response plans that describe the Australian approach to an exotic animal disease incursion. *The procedures are adapted in this manual to apply to eradication of foci of serious infectious diseases of domestic livestock in any country where they may occur.*

The permission of the Department of Agriculture, Fisheries and Forestry, Commonwealth of Australia to use these documents as the basis for the preparation of this Manual is gratefully acknowledged.

The original AUSVETPLAN Operational Manual for Destruction of Animals was drafted by a writing group of Drs L.Pryde, J.Galvin, R.Gordon, J.Murray, M.Riley, and R.Webster; for Disposal Procedures by a writing group of Drs L.Pryde, J.Galvin, R.Gordon, R.Hadwin, J.Murray, M.Riley, and R.Webster; and for Decontamination by a writing group of Drs. G. Abraham. J. Morrison, C. Mayberry, B. Cottam, and R. Gobby and the work of these authors is also gratefully acknowledged.

Introduction

Stamping out is a well-recognised and proven strategy for the rapid elimination of an introduced exotic disease or other emergency livestock disease. The crucial elements of stamping out are the designation of infected zones and within these zones intensive disease surveillance to identify infected premises and dangerous contact premises (or villages), imposition of quarantine and livestock movement restrictions, immediate slaughter of all susceptible animals either on the
infected and dangerous contact premises or in the whole infected area (depending on circumstances - see Part 1); safe disposal of their carcasses and other potentially infected materials; disinfection and cleaning of infected premises; and maintaining these premises depopulated of susceptible animals for a suitable period.

Stamping out is also often the most cost-effective strategy. Not only is the disease eradication campaign shorter and achieved for a lower overall cost, but there is a much shorter waiting period before the country can be recognised as again being free of the disease and export of livestock and animal products resumed.

Several social, economic and other factors need to be carefully evaluated before 'stamping out' is selected as the desired strategy for any specific disease contingency plan. These include:

- whether or not slaughter of infected animals is likely to gain general community acceptance on religious, ethnic, animal welfare and other social and economic grounds ,

- any comparative advantages and disadvantages and likely success of implementation of other strategies. In this context it should be that vaccination is not available for some epidemic livestock diseases and 'stamping out' is the only viable option. African swine fever is such a disease At the other end of the spectrum, for some diseases 'stamping out' is unlikely to have much beneficial effect. This particularly applies to insect-borne diseases such as Rift Valley fever and bluetongue,

- whether or not the manpower, equipment, and other physical resources are available to properly carry out all the activities needed for the implementation of a disease 'stamping out' campaign (see below). Whilst 'stamping out' is likely to be less costly and more efficient overall, it may be quite resource-intensive in the short term,

- whether adequate provisions and mechanisms are available for the fair and quick compensation of owners for any livestock or property destroyed in the campaign.

Well-organised veterinary services that have the full political support of the government for the disease eradication campaign are crucial to the success of the campaign. Also important is the full support of other essential services such as the police, army and public works. The final important element is the prior preparation of a comprehensive contingency plan for the disease in question.

This Manual does not discuss strategic issues. For these reference should be made to the FAO Manual on the Preparation of National Animal Disease Emergency Plans and Manuals on the Preparation of Contingency Plans for Specific Diseases such as Rinderpest and African Swine Fever.

This is instead a procedures manual - how to carry out important activities in a disease stamping-out campaign. It is divided into three parts:

1. Destruction of Animals
2. Disposal Procedures, and
3. Decontamination.

This Manual cannot take into account different circumstances in all countries. It is therefore important that countries simply use it as the basis for preparing their own Manual which is tailored to suit their own requirements and available resources. Where possible, however, an attempt has been made to take into account the circumstances in developing countries and to suggest procedures based on experience of eradication in countries with limited resources.

PART 1

DESTRUCTION OF ANIMALS

1 INTRODUCTION

If an outbreak of a transboundary animal disease or other serious disease occurs and a 'stamping out' policy is adopted for its control and eradication, it may be necessary to destroy a large number of animals. It is essential that these animals are speedily and humanely slaughtered and are indeed dead before disposal of carcasses commences. Speed is of the essence once the disease has been confirmed because, in most situations, the live animals will continue to produce and possibly disseminate the disease pathogen. An experienced veterinarian should be present during destruction. There is likely to be considerable public interest, at least initially, in the destruction of animals. Positive media coverage concerning animal welfare will reflect favourably on staff and increase community support for the eradication campaign.

The destruction of large animals poses perhaps the biggest concern in this regard. They may have to be destroyed individually with firearms, humane killers (captive-bolt pistols), or other means in full public view.

Officers- in-charge must be aware of the impact that animal destruction will have on all people involved. They must quickly acquaint themselves with the skills and experience of all assistants and brief and train them accordingly. Furthermore, they must be aware that some people will be unable to handle the mentally and physically stressful environment likely to be encountered.

Where possible, the livestock owner and his or her family should not be present during the slaughter process as they may experience considerable distress. Counselling and welfare should be made available if needed.

The policy regarding compensation for animals destroyed should be communicated clearly to owners before destruction is attempted. Destruction of animals without adequate compensation of owners is likely to at best meet with serious opposition, and at worst result in large-scale illegal movement of animals and/or their products. Payment of compensation at market-related prices is the only way to ensure owner cooperation and ensure the success of the eradication campaign.

What animals should be slaughtered will depend on the disease in question and the epidemiological circumstances. In some 'non emergency' diseases, e.g. bovine tuberculosis, it may be only necessary to slaughter individual infected animals.

For emergency diseases, one of two options is usually selected:

- If animals in the infected zone are not well-controlled and there is a serious risk of further rapid spread of the disease or spill-over to feral or wild animals, or if inadequate resources are available for surveillance and imposition of quarantine and movement controls, it may be considered more expedient to slaughter all animals in the infected zone, or in specific areas of the zone.

- On the other hand, if animals are well-contained on farms and the necessary resources are available for surveillance and imposition of quarantine and movement controls, the best decision would probably be to only slaughter animals on known infected farms and dangerous-contact premises.

- This decision will also depend on the mode of transmission of the disease, and will differ between diseases that are capable of airborne dissemination over distances and those that require direct contact

2 ORGANISATION OF DESTRUCTION

2.1 Action plan

Planning is essential to ensure the destruction task is carried out efficiently and is not impeded by lack of resources. An action plan should be drawn up in consultation with the owner or his/her agent and appropriate officials. The following procedures should be followed:

The veterinary officer in charge should:

- Fully discuss the situation with affected farmers and village leaders, briefing them on what is going to happen, including the method of compensation.

- Consult with the farm owner/manager, and/or village leaders to establish:
  - farm layout, facilities and equipment;
  - the number, species and location of animals to be destroyed;
  - the destruction technique to be used; and
  - the time-frame for commencement and completion of animal destruction.

- Decide on the appropriate methods and facilities needed for the safe, humane and efficient destruction of the animals.

- Advise the team leader of immediate resources needed to move and secure animals to prepare for their destruction.

- Consult with the OIC of the disposal team if different from the destruction team, determine the disposal method and site to be used and, if necessary, identify centrally-located carcasse disposal sites as close as practicable to the site of destruction.

- Draw up a concise written plan for approval, including:
  - destruction method(s) (see Section 3);
  - destruction site(s) (see Section 5);
  - order of destruction (see Section 6);
  - personnel required; and
  - facilities and equipment needed.

  Details of the destruction operation should be included on a diagram of the infected property (IP) or dangerous contact premises (DCP).

- Make sure that there is a complete inventory of all animals to be destroyed on the property. Destruction should not be delayed because there has been no agreement on valuation. However, where possible, all animals should be valued before destruction. If there is no prior agreement on valuation, close supervision will be required to ensure that all the necessary animals are available for destruction.

- When there is a delay in reaching agreement on valuation with the owner or his/her agent, authority to destroy should be sought in terms of the law/s pertaining to control of animal diseases. However, as pointed out above, this is may endanger the success of the operation and result in a negative perception of animal disease control activities

- Request livestock owners to assemble and confine or restrain their animals on the day before the destruction team starts their operations.

- Ensure that animals not to be destroyed, including domestic pets, are confined well away from the destruction site.

- Send out a team in the surrounding countryside to assess what free-roaming or unrestrained susceptible animals are present.

- Arrange for teams to be sent out to either round up such animals or to shoot or poison them where they are. In some circumstances, helicopter shooting using trained marksmen may be the only option. Proper disposal of such carcasses is essential, as the animals may already be infected.

- Arrange for any necessary support services, e.g. police and army personnel, to be made available.

Before commencing destruction, the team leader should

- When practicable (and applicable), move animals to the centre of the infected premises (IP) or to areas most remote from other susceptible animals including wild animals.

- Brief the destruction teams, then supervise and coordinate their activities. Ensure that:
  - if possible, destruction takes place away from public view;
  - destruction facilities, methods and working conditions are consistent with personal safety;
  - destruction is humane and that no animal is removed for disposal until it is dead;
  - destruction teams receive adequate rest and meal breaks.

- Make every effort to avoid damage to property. Any damage that does occur must be drawn to the attention of the owner/manager, recorded and reported promptly.
- Check all destruction against the authorised inventory to ensure that all variations are accounted for (e.g. births and natural deaths) and that all susceptible animals scheduled to be destroyed on that day have in fact been destroyed.
- Provide team leader a situation report at the end of each day..
- Advise the of resource requirements for the next 48 hours.
- Advise the appropriate officer/s immediately destruction has been completed so that other tasks, e.g. disinfection, can be started without delay. Carcasses and the destruction area should be over-sprayed with disinfectant immediately following destruction.

2.2 Selection of destruction site

The factors that need to be considered in selecting a destruction site are:

- facilities available on site;
- additional facilities and equipment required;
- animal security;
- proximity and ease of access to disposal site;
- safety to personnel;
- acceptability to the owner/manager;
- safe means of transporting carcasses to the destruction site without spillage
  - likelihood of damage to property and services; and
- protection from public view.

2.3 Order of destruction

The order of destruction will be determined by the veterinary officer in charge of the operation. Normally the order will be:

- affected animals;
- their direct contacts; and
- other susceptible animals in descending order of epidemiological importance.

In foot-and-mouth disease, pigs should be destroyed before other species.
Within these groups fractious and potentially dangerous animals, eg bulls, sows with litters, and boars, should be destroyed first.

3 METHODS OF DESTRUCTION

Methods of destruction of animals are listed below. Rabid or suspect rabid animals should be shot in the heart with a firearm to preserve the brain, which is the best diagnostic specimen, and to avoid contamination of personnel with potentially infective brain or saliva. Animals with bovine spongiform encephalopathy (BSE) or scrapie should also not be shot through the head as brain tissue is required for diagnostic testing.

3.1 Firearms (rifles and guns)

Ensure compliance with any firearm licensing requirements, including the use of properly trained and approved operators for rifles and guns.
Part of the preparation process for an emergency disease outbreak is to ensure that firearms operators experienced in shooting livestock can be contacted at short notice. The following aspects of firearms safety should be considered:

- All firearms are potentially hazardous.
- When shooting at short range in stockyards relatively low velocity hollow/soft point ammunition should be used. Solid point ammunition should be avoided because these solid projectiles can penetrate the skull and leave the target at high velocity. This can be dangerous to personnel in the area. Also, hollow point ammunition disintegrates when entering the target, thus more effectively destroying brain tissue (for details see relevant species in Section 4). When paddock shooting, use high velocity, preferably hollow/soft point, ammunition.
- Persons other than the shooters and assistants should be cleared from the area or should stand well *behind* the shooters. The line of fire must be chosen to prevent accidents or injury from stray bullets or ricochets.
- To provide maximum impact and the least possibility of misdirection the range should be as short as circumstances permit.
- Whilst the humane killer pistol and captive-bolt pistol are designed to be pressed firmly on the head before being discharged, it is not safe to do this with a standard rifle or pistol.
- Always notify police before using firearms near populated areas.

The *advantages* of using firearms are:

- clean kill in the hands of experienced operators;
- handling individual animals is not necessary;
- can be used to destroy animals from a distance;
- both firearms and ammunition are readily available; and
- many people are proficient in their use;

The *disadvantages* of using firearms are:
- they are potentially dangerous; and
- unsuitable for use close to populated areas.

3.2 Captive-bolt pistols

Captive-bolt pistols are an acceptable alternative to firearms where animals are sufficiently restrained, provided that the team understands that animals may be stunned rather than killed, are competent to know when an animal is only stunned, and are trained and equipped to kill such an animal immediately after stunning.

Blank cartridges for the captive-bolt pistol are colour coded according to the amount of charge they contain. It is essential that manufacturers' recommendations should be followed on the most appropriate blank cartridges for different farm animals. The most widely used is the 'Cash Special' a single shot .22 calibre captive bolt similar to a revolver. It uses three different loads:

PINK - 1¼ grains (weaners etc)
PURPLE - 2¼ grains (sheep)
GREEN - 3 grains (cattle, boars etc)

Regular maintenance of the captive-bolt pistol is essential for efficient stunning.
When using captive-bolts, more than one operator can work in the same area with safety. Spare weapons and parts should be on hand.

The *advantages* of captive-bolt pistols are:

- operator safety as there is no free projectile;
- both pistols and ammunition are readily obtainable;
- easy to use; and
- operator does not need to be an expert shooter (but must be trained in correct placement of the pistol against the head in the different species).

The *disadvantages* of captive-bolt pistols are:
- they usually only stun larger animals (as a rule-of-thumb, cattle over one-year old, sows, boars, billy goats and rams) which must then be pithed (or bled see Section 3.3) to ensure death;
- some animals have to be individually restrained; and
- they are relatively slow, especially when destroying large numbers of animals.

Humane killers that work on the same principle as the captive bolt but destroy a larger amount of tissue are a better option.

3.3 Pithing

Pithing is the process of destroying nervous tissue in the region of the brain stem to ensure the death of the animal. It is usually done by inserting a rod through the hole made by the captive-bolt in the head to ensure the death of the animal, or by severing the spinal cord between the atlas and axis, that is, between the first and second bones of the neck.

Pithing *unstunned* animals is not an acceptable method of destruction as it is inhumane. It is essential on animals that have been stunned only, e.g. when captive-bolts are used on larger animals (see Section 3.2). Pithing is also a safety measure to prevent workers being struck by the involuntary movements of a stunned animal.
Pithing is preferable to exsanguination (bleeding out) which could release infectious material and make working conditions slippery and dangerous.

3.4 Other physical methods

3.4.1 Dislocation of the neck

This may be suitable for poultry and smaller laboratory animals. Suitable methods are by burdizzo, bone cutters, secateurs or manually. Burdizzos are particularly useful when large numbers of poultry with strong necks (geese, ducks etc) are to be destroyed.

3.4.2 Electrocution

Electrocution is used widely in abattoirs but is not suitable for field use.

3.4.3 Decompression

This method is now regarded as unacceptable.

3.4.4 Exsanguination

Exsanguination, combined with stunning or neck dislocation, of sheep and goats is a humane method of destruction when performed by an experienced operator. However it is undesirable because of the release of infectious material and the destruction site becomes slippery making working conditions dangerous.

3.5 Gaseous agents

3.5.1 Carbon dioxide

Carbon dioxide is the method of choice for destroying most poultry species, when large numbers are involved, and for many laboratory animal species.
Animals must be exposed to an atmosphere of at least 30% carbon dioxide to ensure loss of consciousness and then at least 70% carbon dioxide to kill the animal.

To achieve this, animals may be placed in an air-filled container and then carbon dioxide is allowed to flow into it so that the concentration rises to at least 70%. This level must be maintained for at least 3 minutes. An optimum flow rate is one that will displace 20% of the chamber volume per minute. Animals may be left in the container until rigor mortis ensues or they may be removed once unconscious and killed by cervical dislocation or exsanguination (if appropriate). Up to 20 minutes exposure may be necessary to ensure death and this will be even longer in neonatal or juvenile animals, which are tolerant of carbon dioxide. They may require 30 minutes exposure or longer.

Alternatively, the container may be prefilled with the carbon dioxide/air mixture before animals are placed into it, in which case anaesthesia is said to occur more rapidly (20 seconds to unconsciousness compared to 70 seconds). However some workers have suggested that the latter technique is more stressful.
If cylinders of carbon dioxide are not available, dry ice may be used. This is placed in the bottom of a deep container under a gauze floor, such that there is not direct contact with the dry ice. Animals are then placed into the container, and left there until unconsciousness or death ensues as before.
The use of a carbon dioxide/oxygen mixture (70/30) is said to decrease the discomfort of hypoxia before the onset of anaesthesia and narcosis. However this will complicate the procedures by requiring additional cylinders of oxygen and reducing valves.

Carbon dioxide is safe and easy to use as long as it is used in a well ventilated area.

3.5.2 Gaseous anaesthetic agents

These agents, which include halothane, enflurane and isoflurane, can be used to produce anaesthesia and death. Halothane at concentrations greater than 4% can produce anaesthesia and cardiac arrest in 90 seconds. These agents can be used in exactly the same way as carbon dioxide, that is, piped into a container with a carrier gas such as oxygen, or poured onto cotton wool and placed under gauze at the bottom of a deep container. Again there should be no direct contact between the animal and the anaesthetic in the liquid form.

The major disadvantages are that these agents are expensive and should only be used in a well ventilated room or preferably in a fume cupboard, as prolonged exposure, even at low concentrations may be detrimental to the health of personnel. As with carbon dioxide, animals may be left in the anaesthetic chamber until dead or may be removed once unconscious and killed by one of the physical methods or even by injection of an overdose of barbiturate as detailed below.

Ether is not recommended. Induction of anaesthesia is slow and stressful as the high concentrations of the vapour necessary to produce unconsciousness are irritant to skin and mucous membranes. Ether is also hazardous to personnel due to its explosive properties both during use and when disposing of carcasses after death.

3.5.3 Hydrogen cyanide gas

Hydrogen cyanide gas is a highly effective method of destroying poultry, however human safety considerations restrict its use. It is not recommended.

3.5.4 Carbon monoxide

Carbon monoxide can be used to destroy poultry. It is readily available from car exhaust but unleaded petrol vehicles produce less than super petrol and the fumes must be cooled. Human safety considerations restrict its use.

3.5.5 Methyl bromide

Methyl bromide is similarly effective at killing poultry but operator safety requirements restrict its use also. There are people trained in its use in all agriculture departments. It is also virucidal. Environmental concerns are now restricting its use.

3.6 Injectable agents

An overdose of any of the barbiturates can be used for euthanasia, ideally by the intravenous route in large animals but the intracardiac or intraperitoneal route may be preferable in smaller animals. Destruction of cats, rabbits and some birds by intraperitoneal sodium pentobarbitone may be accompanied by an excitement phase. Animals should be confined and handled with extreme care. Specific euthanasia solutions are available (sodium pentobarbitone 325 mg/kg). This should not be used by the intrathoracic, subcutaneous or intramuscular route as at this concentration it is extremely irritant to tissues. Pentobarbitone at the normal concentrations used for anaesthesia may also be used but obviously larger volumes will be required.

If the animals are excitable or vicious, other drugs can be administered to chemically restrain them. These drugs such as tranquillisers, analgesics or other depressants like ketamine, opioids or xylazine, can be given by the subcutaneous or intramuscular route. An overdose of barbiturate can then be given intravenously to kill the animal.
These agents are restricted by law and must only be used by a veterinarian or under veterinary supervision.

4 DESTRUCTION OF VARIOUS SPECIES

The preferred methods of destruction of various domestic species and the factors that determine the selection are presented below.

4.1 Cattle and buffalo

Under most circumstances cattle and domesticated (water) buffalo will be mustered into yards and shot using firearms. In extensive areas where 100% musters cannot be achieved, unmustered animals will be paddock shot after first mustering as many as possible.
Captive-bolt pistols are most suitable when animals can be adequately restrained (but see Section 3.2). Injectable agents may be most suitable for small numbers of calves, such as on hobby farms.

4.1.1 Frontal method

The firearm should be directed at the point of intersection of lines taken from the base of each horn (or equivalent position in polled animals), to the opposite eye aiming at the spine (see Figure 1a). For bulls or older animals the bullet should enter about 1 cm to the left or right of this point and hard point/jacketed ammunition may be necessary. Small calves may be shot just behind the nuchal crest (poll) in the mid-line aiming directly at the muzzle (see Figure 2). Alternatively, a captive-bolt pistol using cartridges may be used.

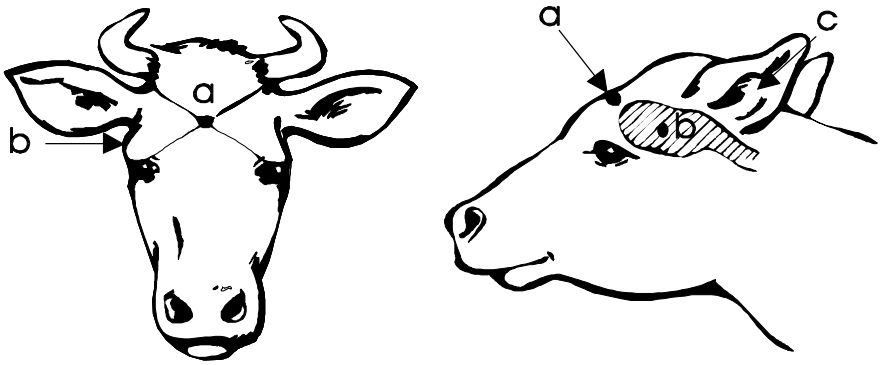


Figure 1 **Humane destruction of cattle; (a) recommended position for frontal method (suitable for firearm or captive-bolt pistol); (b) recommended position for temporal method (only suitable for firearms); (c) recommended position for small calves**

4.1.2 Temporal method

This is only suitable for firearms. The animal is shot from the side so that the bullet enters the skull midway between the eye and the base of the ear. The bullet should be directed horizontally (Figure 1b).

4.1.3 Shooting in yards

Ideally only personnel who have had previous experience in this type of work should undertake this task. If such personnel are not available, the task may be allocated to police or army marksmen. They should be fully briefed on humanitarian and safety aspects of destruction before commencing yard shooting. Only hollow/soft point ammunition should be used. The minimum calibre should be 0.22 magnum; maximum calibre should be 0.44 magnum (240 grain) or 0.375 (250 grain).
Operate from top rail, preferably in a small yard. It is not practical to shoot in a crush unless dealing with very small numbers and the crush is equipped with a side opening gate, in which case a captive-bolt pistol should be considered.

4.1.4 Paddock/extensive area destruction

Shooting from helicopters where available is usually the most effective method of destroying unmusterable cattle. Appropriate civil aviation authority approval may be needed before rifles may be used from helicopters. Again this should be carried out only by experienced personnel specifically trained and with current proficiency in this type of operation. Untrained personnel should undergo a training course and pass a practical and written test at its conclusion before shooting from a helicopter. Minimum recommended calibre is .308 soft point using military type semiautomatic rifles e.g. M14, SLR or MIA.

Shots aimed to destroy the brain are preferred, but for practical reasons this is not generally possible with helicopter shooting, in which case heart/lung shots can be used.

The problem of rapidly destroying large numbers of cattle on intensive feedlots is not easy to resolve. The possibility of using a lethal oral agent in water or feed should be considered.

4.1.5 Technique for domesticated (Asian) buffaloes

As for cattle except:

- hard point/jacketed ammunition is preferable for large animals;
- for small numbers, when use of semi-automatic rifles is not critical, use heavier calibre or magnum rifles;
- frontal shooting — be mindful of angle of impact as buffalo will often elevate their nose.

4.2 Sheep

The preferred method of destruction is by .22 rifles or captive-bolt pistols.

4.2.1 Hornless sheep

The top of the head (centre of upper forehead) is a suitable position with the firearm or captive-bolt being aimed towards the animal's gullet. Alternatively the instrument may be placed just behind the poll and aimed in the direction of the animal's muzzle. Both methods are illustrated in Figure 2.

4.2.2 Horned sheep

If using a captive-bolt, the top of the head position used for hornless sheep may not be suitable, in which case the instrument may be placed behind the poll and aimed in the direction of the animal's muzzle (see Figure 3a). If using a firearm, shoot at a point in the middle of the face just above the level of the eyes whilst aiming towards the spine as shown in Figure 3b.

- *Rams* — it may be easier to use .22 magnum rifle, depending on facilities. If captive-bolt is more practical heavy duty cartridges should be used (see section 3.2).
- *Wethers/ewes* —Sheep must be packed tightly as destruction proceeds. This can be achieved using light portable panels or mesh.
- *Newborn lambs* — should be drafted off and administered sodium pentobarbitone (intraperitoneal 3–5 mL through automatic syringes).

Figure 2 **Humane destruction of hornless sheep, recommended positions and direction of fire for captive-bolt pistol or firearm**

Figure 3 **Humane destruction of horned sheep; recommended position and direction of fire for (a) captive-bolt pistol; or (b) firearm**

4.3 Pigs

Pigs are particularly difficult to destroy. Captive-bolt pistols/heavy calibre humane killers should be used for housed pigs to avoid the danger of ricochets. Housed pigs may be moved outside and destroyed using firearms. Sows with litters are particularly fractious and difficult to handle. Pigs in paddocks can be shot using firearms.

Use sodium pentobarbitone on unweaned pigs. Intraperitoneal injections of 3–5 mL of a suitable product using automatic syringes is satisfactory.

4.3.1 Frontal method

The captive-bolt pistol or firearm should be directed at a point about midway across the forehead and (for adult pigs) about 2 cm above the level of the eyes (Figure 4a).

4.3.2 Temporal method

This is only suitable for firearms. The pig is shot from the side so that the bullet enters the skull at a point midway between the eye and the base of the ear. The bullet should be directed horizontally into the skull (Figure 4b). This method is preferred for adult pigs due to the heavier bone structure of the front of the skull. Feed one-third of the normal ration before commencement of destruction. Pigs will stay calmer and therefore be easier to handle. If slaughter is likely to be delayed, ensure sufficient feed is on hand.

- *Growers* — pack in tight; work round perimeter of yard, then climb in to finish balance of group. Pigs usually quieten as destruction progresses.
- *Sows* — do not yard too tightly as they become upset if jammed and will start climbing on rails; work steadily — do not hurry. Use heavy duty cartridges in captive-bolt pistols (see section 3.2).
- *Boars* — use heavy duty cartridges in captive-bolt (see section 3.2) or, if this is too difficult, use a .22 magnum rifle.
- *Small pigs* — use standard captive-bolt cartridges (see section 3.2). It is preferable to have them caught and held over the rail of the yard while destroyed. A wheelbarrow can then be a useful means of conveying to the front-end loader.

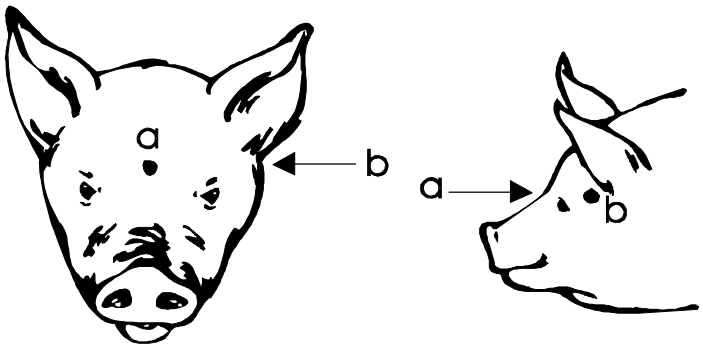


Figure 4 **Humane destruction of pigs; recommended position and direction of fire for (a) frontal method (suitable for captive-bolt pistol or firearm); or temporal method (suitable for firearm only)**

4.4 Goats

Using either a captive-bolt pistol or firearm, direct the instrument to the skull behind the horns as shown Figure 5. Aim the firearm in line with animal's mouth.
Kids may also be shot from the front as for cattle. This method is not suitable for mature goats as the brain is located well back in the skull compared to other livestock. Sodium pentobarbitone is also appropriate (as for lambs).
Newborn kids should be drafted off and sodium pentobarbitone administered (intraperitoneal 3–5 mL of a suitable product).

Figure 5 Humane destruction of goats; recommended position and direction of fire (captive-bolt pistol or firearm)

4.5 Horses, donkeys and mules

Animals can be destroyed either by intravenous injections of euthanasing drug or shooting, as detailed below.

4.5.1 Frontal method

The firearm should be directed at the point of intersection of diagonal lines taken from the base of each ear to the opposite eye aiming at the spine (Figure 6a).

4.5.2 Temporal method

The horse is shot from the side so that the bullet enters the skull midway between the eye and the base of the ear (Figure 6b). The bullet should be directed horizontally.

Recommended rifles for horses are 0.22 magnum (hollow point) or 0.44 magnum. Captive-bolt pistols are not recommended for horses because some horses rear before the operator can withdraw the bolt or move out of danger. Horses in the public view can be exsanguinated humanely by severing the abdominal aorta per rectum.

4.5.3 Paddock/extensive area destruction

As for cattle and buffalo (see Section 4.1).

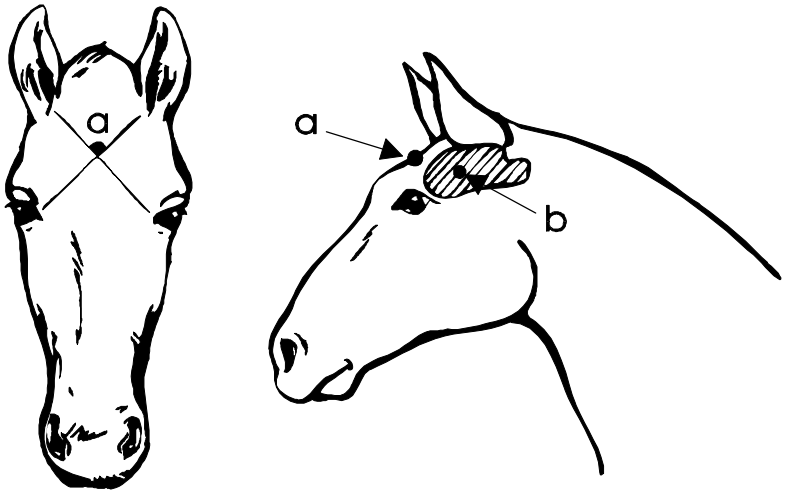


Figure 6 **Humane destruction of horses; recommended position and direction of fire for (a) frontal method; or (b) temporal method**

4.6 Deer

A firearm or captive-bolt pistol should be directed at the forehead where lines taken from the base of each ear to the opposite eye intersect (Figure 7a). A firearm should be fired horizontally into the forehead. If using a captive-bolt on adult bucks, heavy duty cartridges are necessary.

If the deer are disturbed when approached from the front, an equally effective method is to fire the instrument through the skull just behind the base of the antlers. The weapon should be aimed in line with the animal's muzzle (Figure 7b).

Figure 7 **Humane destruction of deer; recommended position and direction of fire for (a) firearm or captive-bolt pistol; or (b) alternative position for disturbed deer**

4.7 Birds

For small numbers of birds, eg fancy breeds, pigeons, the preferred methods are dislocation of the neck (using burdizzos, bone cutters, secateurs or bare hands) or intracardiac or intraperitoneal injection of sodium pentobarbitone.

For large numbers of birds in commercial poultry units the preferred method is gassing with carbon dioxide. This method involves lining large garbage waste bins (skips) with plastic sheeting that also forms a canopy over the top of the bin.

Birds can be caught using teams of 10–15 labourers. Experienced catching teams may be available. Chicks are easily caught under heaters and are transferred to skips in plastic garbage bins. Broilers on the ground are driven, using a movable hessian wall, to the catching area where they are caught and placed directly into skips.

Caged birds are more difficult and progress is slower. Each catcher removes 3 or 4 birds from cages and carries them by the legs to skips.

Layers on perches are best caught at night or during low light when they are quiet.
Carbon dioxide is transferred to the bottom of the skips through one inch garden hose fitted to the top of the cylinders. The carbon dioxide should be decanted in 30–45 second bursts. It is essential not to decant too quickly or the bottles will freeze when about half empty.

On average half a 45 kg cylinder of carbon dioxide is needed for the three cubic metre skips and 3 or more cylinders for the 20 cubic metre skips. Carbon dioxide should be added at a sufficient rate to ensure birds succumb before other birds are placed on top of them. Skips should be three quarters filled with birds, sealed and transported to the disposal site. Care must be taken to ensure no bird is still alive when dropped into the burial pit. Should this happen birds must be immediately caught and humanely killed.

For humane destruction of farmed ostriches, birds should be restrained firmly and dispatched by captive bolt or injection of sodium pentabarbitone into the jugular vein.

4.8 Dogs

Injectable agents are the best method of destruction of dogs that can be handled. Intravenous sodium pentobarbitone (40 mg/kg) is the ideal method. Intracardiac injections are favoured for puppies and small dogs. Other drugs given subcutaneously or intravenously may be used initially, for example xylazine (2 mg/kg) or ketamine (20 mg/kg), if necessary by using a tranquilliser gun. Once the dog is sedated intravenous barbiturates can be used to kill the animal.

If a tranquilliser gun is not available, injection by any route will be too dangerous for some totally unmanageable dogs and for suspect rabid or rabid dogs. A lasso on a pole may be useful to help catch and control these dogs. Including a sedative (eg sodium pentobarbitone) in the food may be an appropriate preliminary to an injectable agent. Dogs may have to be restrained with muzzles or tape before destruction.

Some dogs will have to be shot through the heart.

4.9 Cats

Injectable agents are the best method of destruction of cats. Intravenous or intracardiac sodium pentobarbitone (40 mg/kg) is the preferred drug. Alphaxalone (Saffan®) may be used as a preliminary. Intraperitoneal injections can cause excitation before death. Tranquilliser guns are not suitable for cats as they are a small fast-moving target.

Animals that are not easy to handle may have to be put in a hessian bag, injected through the bag and left in a cage until dead. Alternatively they can be placed in a plastic bag or box into which any of the anaesthetic gases (including carbon dioxide) are piped with oxygen as the carrier gas. Anaesthesia is usually quick and quiet but death may take some time (at least 20 minutes with carbon dioxide but less with some of the other anaesthetic gases). Once the animal is unconscious it may be removed and killed with an overdose of barbiturate.

4.10 Rats, mice, guinea pigs

Any of the physical or chemical methods described above can be used in a laboratory, but the method of choice is carbon dioxide. Newborns are resistant to carbon dioxide and need prolonged exposure, or a combination of carbon dioxide and cervical dislocation. When using pentobarbitone this should be given by the intraperitoneal route (rats and mice 100 mg/kg, guinea pigs 90 mg/kg).

4.11 Rabbits

Physical methods such as cervical dislocation should only be used by skilled personnel and only on rabbits less than 1 kg in weight. The preferred method for laboratory rabbits is intraperitoneal pentobarbitone 60 mg/kg. Intravenous barbiturate injections of the very concentrated barbiturate euthanasia solution into the ear vein are often painful and may be distressing. Therefore standard anaesthetic solutions should be used. Rabbits

should be restrained since an excitement phase may occur especially if the intraperitoneal or intravenous injection is incorrectly administered.

Induction of anaesthesia with carbon dioxide as described for birds and cats is slow and animals appear to become apprehensive before unconsciousness supervenes and therefore is not recommended. Overdosage with other inhalation anaesthetic agents may be used.

4.12 Primates

Chemical restraint by means of ketamine (20 mg/kg intramuscularly) followed by an overdose of barbiturate given by the intravenous or intracardiac route (50 mg/kg) is recommended for laboratory primates.

4.13 Fish

A sharp blow to the head followed by destruction of the brain has been recommended as a physical method of euthanasia. If chemical methods are preferred, an overdose of anaesthetic such as MS222 (tricaine methane sulphonate) can be used or carbon dioxide can be bubbled into the water. This should be followed by destruction of the brain.

4.14 Circus and zoo animals

The assistance of a veterinarian with experience of handling (and destroying) circus and zoo animals should be sought. If none is available the methods outlined above should be extrapolated to the various species.

GLOSSARY

Ammunition	
– hard point	Hard metal ammunition; passes through tissues cleanly and can leave the target at high velocity causing danger to other people/animals in the area. .
– soft/hollow point	Ammunition made of softer metal, or with a hollow point that tends to flatten on impact causing greater damage to tissues, but does not exit the target unless it fails to encounter bone or solid muscle.
Burdizzo	Castrating pincers.
Captive-bolt pistol	Humane animal killer — takes either a blank cartridge that delivers a knockout blow to the skull; or a penetrating bolt that is driven a short distance into the brain. The operator does not have to be a marksman as the instrument's muzzle is firmly pressed against the animal's skull before firing.
Disinfectant	An agent used to destroy micro-organisms outside a living animal.
Disposal	Sanitary removal of animal carcasses and other infected material by burial, burning or some other process so as to prevent the spread of disease.
Exsanguination	Severe loss of blood.
Firearm	Small arms weapon (guns and rifles).
Infected premises	A defined area (which may be all or part of a property) in which an exotic disease exists, is believed to exist, or in which the infective agent of that exotic disease exists or is believed to exist. An infected premises is subject to quarantine served by notice and to eradication or control procedures.
Infected premises operations team	Team appointed by the LDCC controller to coordinate/supervise operations at the infected premises.
Injection sites	
– intracardiac	into the heart
– intraperitoneal	into the peritoneal (abdominal) cavity
– intramuscular	into muscle (the needle is passed deeply into the substance of a muscle before the fluid is injected)
– intrathoracic	into the thoracic (chest) cavity
– intravenous	into a vein
– subcutaneous	under the skin (hypodermic)
Nuchal crest	Transverse bony ridge across the back margin of the roof of the vertebrate skull.
Poll	Crown of the head
Quarantine	Legal restrictions imposed on a place, animal, vehicle or other things limiting movement.
Susceptible animals	Animals that can be infected with the disease

PART 2

DISPOSAL PROCEDURES

1 INTRODUCTION

The primary objective of disposal of carcasses, animal products, materials and wastes is to prevent the dissemination of infection. This process is therefore an part of an emergency animal disease eradication program, particularly when a 'stamping out' policy is followed. It is also important from an aesthetic point of view. Disposal should be completed as soon as possible after destruction to minimise opportunities for infectious material to disperse. Furthermore, carcasses are much easier to handle before decomposition has set in.

This manual outlines disposal methods appropriate for the emergency animal diseases that are most readily transmitted by fomites (ie foot-and-mouth disease, Newcastle disease, African swine fever, and avian influenza) and zoonotic diseases. Less rigorous disposal methods may be appropriate for less readily transmitted diseases and non-zoonotic diseases. Carcasses and other items awaiting disposal should be guarded to prevent unauthorised access and to prevent domestic pets, wild animals and birds removing potentially infectious material. Control of insects should be considered if there is a risk of passive transmission by insects to nearby susceptible species. If disposal is delayed, carcasses should be thoroughly sprayed with an approved disinfectant.

Before commencing disposal work, personnel should be fully briefed. The nature of the disease and any specific hygiene requirements associated with zoonotic diseases should be explained on site.

Respirators should be supplied to personnel when there is any risk to humans from the organism involved, or if large amounts of dust are generated.

2 SELECTION OF DISPOSAL METHOD AND SITE

It is crucial to select a site which is well-protected from scavenging animals and people. On some occasions it may be necessary to mount a guard at the site for the first few days.

2.1 Disposal on the infected premises (or dangerous contact premises)

Depending on local circumstances, burial may be the preferred method of disposal because it is:

- quicker;
- cheaper;
- environmentally cleaner; and
- easier to organise, i.e. fewer outside resources required (see Section 3.1).

General factors to be considered are:

- nature and amount of material for disposal;
- availability of sites suitable for burial or cremation adjacent to the destruction site;
- accessibility to disposal site by heavy transport vehicles;
- nature of soil/rock formation in the available area;
- level of water-table;
- proximity to water catchment areas, bores and wells;
- presence of underground services, eg water, gas, electricity, telephone lines, drainage, sewerage, other improvements or structures, including aerial lines;
- proximity to built-up areas and dwellings (particularly in the case of cremation);
- fire restrictions, hazards (in the case of cremation);
- weather conditions including prevailing winds (it may be easier to cremate in excessively wet conditions);
- availability of plant for burial;
- availability of supplies of suitable fuel for cremation;
- presence of overhead structures such as power lines; these must be avoided when selecting both burial and cremation sites;
- quantities of carcasses and other material for disposal; and
- subsequent plans for the use of the area, eg the soil may be unstable where burial pits are placed.

Disposal of animal carcasses and other infectious material may involve some adverse environmental consequences. It is important for the environmental aspects of proposed disposal activities to be properly considered, with advice from environmental agencies where possible, so as to ensure that the impact of such consequences be minimised. Consultation with relevant authorities, eg environmental protection agencies, will be necessary to obtain specific information on a number of these factors.

2.2 Disposal off the infected premises (or dangerous contact premises)

Where burial, cremation or rendering are not considered practical or difficult to carry out on the infected or dangerous contact premises, consideration could be given to transferral of carcasses and/or infectious material to another site for disposal by burial, cremation or rendering. This may be necessary when considering the disposal of materials from laboratories and in situations where site limitations, such as available space or water-table, effectively prevent on-site disposal. Furthermore, in some circumstances, such as with large volumes of material from feedlots, it may be preferable to dispose of carcasses by rendering if suitable facilities are available locally or can be transported to the site.
If infectious and dangerous contact premises are adjacent or in close proximity, a common disposal site may be used.

Transport should be in a leak-proof container, such as a large skip, covered with tough polyethylene covers and sealed at the top. It should not be overloaded — half a metre or more (depending on distance to be travelled and temperature) should be left clear for expansion of carcasses. Carcasses should not be slashed before loading. Vehicles should travel slowly to avoid splashing of contaminated material. Staff should carry a supply of an approved disinfectant and basic equipment to deal with minor spills en route. All vehicles must be cleaned and disinfected before leaving the premises and after unloading.

3 METHODS OF DISPOSAL

3.1 Burial

3.1.1 Site selection

Important considerations for burial site selection include;

- *access to the site* — for both equipment to dig the burial pit and for the delivery of livestock, carcasses or other materials to be buried;
- *environmental* — distance to watercourses, bores and wells; height of water-table; proximity to buildings, especially houses; proximity to neighbours or public lands including roads; slope of the land and drainage to and from the pit; permeability of soil; sufficient space for temporary storage of overburden; and direction of prevailing wind (odour);
- *construction considerations* — avoid rocky areas (slows digging and increases costs) but select soils with good stability capable of withstanding the weight of equipment used to construct and fill the pits. Surface runoff should be prevented from entering the pit by the construction of diversion banks if required. Similar banks should be constructed to prevent any liquids escaping from the burial site. Fencing may be necessary to exclude animals until the site is safe for use.

3.1.2 Earthmoving equipment

The preferred equipment for digging burial pits is an excavator. This equipment is the most efficient available for the construction of long, deep, vertically sided pits. Other advantages include the ability to easily store topsoil separate to subsoil and the equipment can be used if required to fill the pit with carcasses or other materials and closing the pit without disturbance of the carcasses.

Loaders, bulldozers, road graders and backhoes or manual labour (for small jobs) may be used if excavators are unavailable. With the exception of backhoes, all other equipment requires the continual movement of the machine over the site while digging the pit. Excavators and backhoes essentially remain in a fixed position while digging, hence they move soil faster, with less cost and less damage to the site surrounding the pit. Most excavators have an attachable hammer for rock work if necessary.

3.1.3 Burial pit construction

The dimensions of the burial pit will be dependent on the equipment used, site considerations and the volume of material to be buried. The preferred dimensions are for pits to be as deep as practically possible (reach of machinery, soil type and water-table level being the usual constraints), with vertical sides. The pit should be no wider than can be filled evenly with the material to be buried with the available equipment. For example if a bulldozer is used to dig a pit, then it should be no more than one blade width, say 3 metres, because it may be very difficult to push carcasses into the pit from one side and evenly fill the pit. The aim should be to avoid having to move carcasses once they are in the pit. The length of the pit will be determined by the volume of material to be buried.

Pit dimensions
In designing the dimensions of the pit, consideration needs to be given to the method to be used to fill the pit with carcasses or other material. Generally carcasses will be unloaded (out of tip trucks) or pushed into the pit (loader or bulldozer) from one of the long sides. Excavators can be used to fill pits with carcasses placed close by the pit. This is especially useful if soil stability does not permit trucks or other heavy equipment to operate close to the pit edge.

The following guidelines may be of assistance in determining the pit volume required. The base of the pit must be at least 1 metre above the water-table. On average, allow a fill capacity of about 1.5 cubic metres for each adult beast or 5 adult sheep. In addition, at least 2 metres of soil is required to cover carcasses to ground level. For example, a pit 3 metres wide and 5 metres deep filled with carcasses to within 2.5 metres of ground level will accommodate 5 adult cattle per linear metre (ie 3 x 2.5 x 1 = 7.5 cubic metres; 7.5/1.5 = 5 cattle or 25 sheep).
When closing the pit, surplus soil should be heaped over the pit as overfill. The weight of soil prevents carcasses from rising out of the pit due to gas entrapment, prevents scavengers digging up carcasses, helps filter out odours and assists in absorbing the fluids of decomposition. After pit subsidence it will be necessary to replace any topsoil not utilised during pit closure.

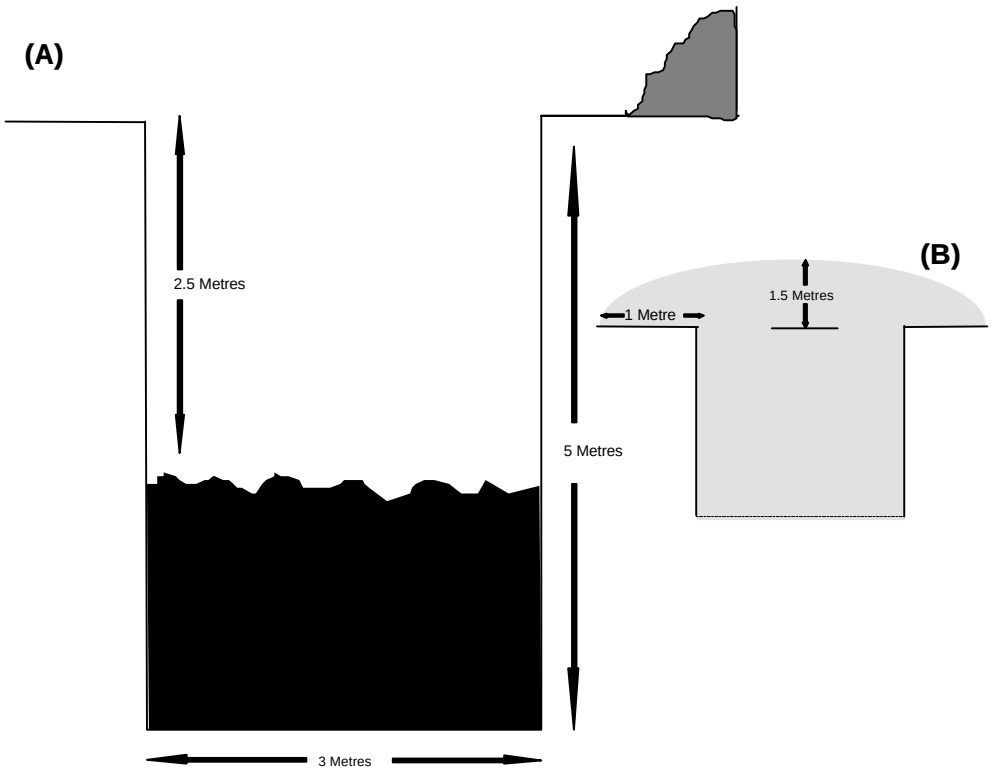


Figure 1 **Disposal of carcasses by burial; (A) open pit; (B) freshly closed pit**

In the case of poultry, destruction will normally be in a container such as a skip or body of a truck and the dimensions of these containers should be used as a guide to the volume of the pit required.

3.1.3 Other considerations

Gas production

Gas production from decomposition within unopened carcasses may result in considerable expansion in the volume of the buried material to the extent that the surface of the closed pit may rise and carcasses may be expelled from the pit. It is recommended that large animal carcasses be opened by slashing the rumen of cattle or the caeca of horses to permit escape of gas. There appears to be little benefit in opening small animal carcasses. If carcasses are to be opened this should be undertaken at the side of the pit, under no circumstances should personnel enter the pit during filling.

Lime should be added to pits to prevent earthworms bringing contaminated material to the surface after pit closure. Cover the carcasses with soil, 400 mm is suggested, and add an unbroken layer of slaked lime [$Ca(OH)_2$] before filling is completed.

Lime should not be placed directly on carcasses because when wet it slows, and may prevent, decomposition.

Site inspection

Inspection of the burial site after closure is recommended so that appropriate action can be taken in the event of seepage or other problems. The objective is that the site should return to its original condition. Before restocking is permitted the burial site should be again inspected to ensure there is no possible biological or physical danger to stock. This would normally be several months following pit closure.

Safety considerations

Safety of personnel is an overriding consideration. Aspects to consider include: hygiene of the personnel working on the site; the availability of rescue equipment if a person falls into the pit or if the pit wall collapses; hearing and dust protection. All operations should be controlled by the site supervisor/team leader and staff properly briefed before the commencement of operations.

3.2 Cremation

Cremation should be considered only when burial is not possible. However, In countries where earth-moving equipment may not be readily accessible to ensure deep burial and/or where putrefaction is not a deterrent and poverty dictates that eating habits should not be fastidious, cremation is preferred. Available methods include funeral pyres, existing incinerators and pit burning.

3.2.1 Pyres

The principle is to place carcasses on top of sufficient combustible material, ensuring the arrangement of fuel and carcasses allows adequate air flow to enter the pyre from below, so as to achieve the hottest fire and the most complete combustion in the shortest time.

3.2.2 Site selection

Important considerations are:

- *location* — consider the possible effects of heat, smoke and odour that will be generated by the fire on nearby structures, underground and aerial utilities, roads and residential areas;
- *access to the site* — for both equipment to construct the pyre and maintain the fire and for the delivery of fuel and livestock, carcasses or other materials to be burnt;
- environmental — ensure there is an adequate fire break around the pyre — consult with local bush fire brigades or residents for advice, permits if required and for fire appliances to be on site during the burn;
- *fuel* — pyres require considerable fuel to achieve complete cremation. The amount and type of fuels available will vary considerably, all required fuel should be on site before the burn is commenced.

3.2.3 Preparation of fire-bed

The fire line should be sited at 90 degrees to the direction of the prevailing wind to maximise ventilation. Air space can be provided by digging trenches under the pyre and/or elevating the fire-bed. Fuel supplies should be stacked and the fire built from the upwind side and carcasses loaded from the opposite side.

- *Width* of the fire-bed is governed by the size of carcasses to be burnt, for adult cattle allow 2.5 metres.
- *Length* — allow 1 metre per adult beast.

If building the fire-bed on the ground, dig trenches, (30 cm x 30 cm) to act as air vent channels, in the same direction as the prevailing wind at about 1 metre intervals under the length of the proposed fire-bed. If elevating the fire-bed lay rows of baled straw and heavy timbers parallel to the prevailing wind and then another layer of timbers crossing the bottom layer with a gap of about 20 cm between timbers. Then lay other fuel, such as lighter timber or straw bales, over this timber support.

Stack carcasses across the fire-bed with larger carcasses on the bottom and smaller carcasses on top (see Figure 2), preferably with the carcasses on their backs and alternating head to tail, if possible. Excavators or front-end loaders are best, but lifting jibs, tractor fork-lifts or cranes and chains can be used. After placing carcasses on the fire-bed the extensor tendons may be cut to prevent legs being extended during burning.

When loading of the carcasses is complete and weather conditions suitable, saturate the fire-bed and carcasses with diesel or heating oil (NOT PETROL) and prepare ignition points about every 10 metres along the length of the fire-bed. These can be made of rags soaked in kerosene.

Remove all vehicles, personnel and other equipment well away from the fire-bed. Start the fire by walking into the wind and lighting the ignition points along the way.
The fire must be attended at all times and be re-fuelled as necessary, use a tractor with a front mounted blade or a front-loader. Ensure any carcasses or parts thereof that fall off the fire are replaced on the fire. A well-constructed fire will burn all carcasses within 48 hours. The ashes should be buried and the site restored as well as possible.

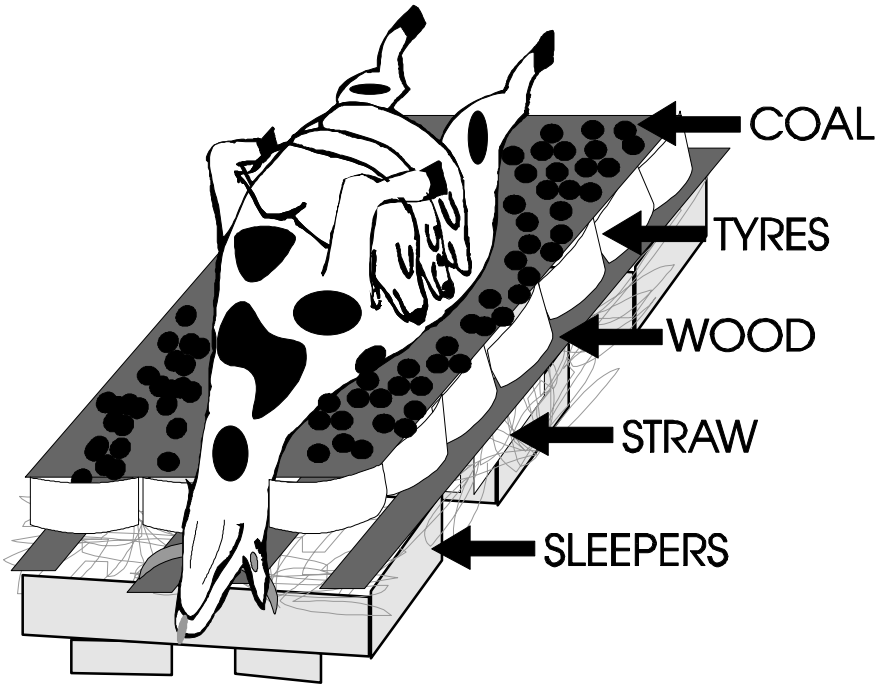


Figure 2 Disposal of carcasses by cremation

3.2.4 Fuel requirements

Local availability will govern the type and amount of various fuels required. The following can be used as a guide (per adult beast);

- heavy timber 3 pieces, 2.5 m x 100 mm x 75 mm
- straw 1 bale
- small timber 35 kg
- coal 200 kg
- liquid fuel 5 litres

For fuel estimation, one adult cattle carcass is equivalent to 4 adult pigs or shorn sheep, or 3 adult woolly sheep.

3.3 Incinerators

Biological incinerators are a very efficient carcass disposal system, achieving safe and complete disposal with the absence of virtually any pollution. However, their cost (establishment and operation) and lack of portability means they are unlikely to be readily available or easily accessible in most situations. Incinerators are usually only suited to disposal of small amounts of material. Special procedures must be followed in connection with the transportation of infected material off infected premises to the incinerators and the disinfection of containers and vehicles.

3.4 Pit burning

Pit burning (also known as air curtain incineration) is a technique for burning material in a pit aided by fan-forced air. Pit burners are used by some local authorities to burn vegetable matter with a high moisture content. The equipment consists of a large capacity fan (usually driven by a diesel engine) and ducting to deliver the air, which may be preheated, down into the long side of a trench. The angle of the airflow results in a curtain of air acting as a top for the incinerator and provides oxygen that produces high burn temperatures. Sufficient hot air recirculates within the pit achieving complete combustion. Additional fuel is required to initially establish combustion, but once operating the continuing fuel requirement is reduced. Pit burners would be suitable for continuous operation on a relatively small scale and have the advantage of being transportable. They would appear to be especially suited to pigs and fat sheep.

In countries where mechanical equipment is difficult to obtain and the above methods appear sophisticated, a combination of burning and burial has been used successfully to dispose of pig carcasses and would be suitable for small ruminants and possibly small numbers of cattle as well. After the trench had been dug, it was

lined with old motor tyres, on which the carcasses were placed. The carcasses were soaked with diesel and ignited with a SMALL amount of petrol. Fires were watched until the carcasses were burnt and then the trench was covered over.

3.5 Rendering

Rendering may be an option for the disposal of carcasses if suitable plants are available. Only rendering plants using a high temperature batch rendering process should be used. A satisfactory rendering process would involve grinding the raw product, solvent extraction of lipids at about 100°C for one hour and high temperature (160°C) treatment of both carcass meal and tallow for at least a further 40 minutes.

The end product of rendering must pass relevant microbiological tests before release.

3.6 Composting

Where there is a minor risk of fomite spread, composting of stable manure, feeds, hay, litter and bedding is a possible alternative to burial or burning. Composting should be done in a secure area not accessible to susceptible animals.

4 ITEMS REQUIRING SPECIAL CONSIDERATION

All contaminated and potentially-contaminated carcasses, animal products, materials and wastes should be disposed of by one of the methods outlined in Section 3. However, specific disposal considerations apply to the materials listed below.

4.1 Milk and dairy products

The disposal of milk products presents particular difficulties because large volumes are often involved. It is essential that milk should be treated to inactivate any virus before disposal (see the Decontamination Manual, Section 6). Following inactivation, disposal options need to be considered. Usually milk held on-farm is in small quantities and can be disposed of in the burial pit. On those properties where carcasses are cremated, milk should be disposed of in the effluent pit.

Where there are large volumes of contaminated milk at dairy factories or in tankers this should always be inactivated then pumped into a shallow fenced-off pit, which is covered over after the milk has evaporated or seeped into the surrounding soil.
Effluent (washing from dairy factories) presents special problems because of sheer volume. Chemical treatment of large volumes of effluent may render it unacceptable to a sewage disposal unit but 0.2% citric acid should cause no problems. The actual danger from effluent is greatly reduced by dilution and the free use of above normal quantities of water in the usual cleaning processes will further reduce the danger.

Where effluent is normally irrigated over pastures these should not be grazed for two weeks after irrigation. Rennet, casein, whey or other wastes must not be sprayed over pastures, discharged into drains, or fed to animals, unless treated with disinfectant, as for milk.

4.2 Hatching eggs and hatchery waste

Before disposal of hatching eggs and hatchery waste into burial pits, all material should be macerated to ensure extinction of all life. Assistance of the poultry industry should be sought for supply of suitable equipment and guidance on its use.

4.3 Effluent

Small amounts of solid manure may be disposed of by burial or cremation. See Decontamination Manual, Section 6.

4.4 Wool and mohair

If required, these by-products should always be buried because they do not burn well.

GLOSSARY

Animal by-products	Products of animal origin destined for industrial use, eg raw hides and skins, fur, wool, hair, feathers, hoofs, bones, fertiliser.
Animal products	Meat products and products of animal origin (eg eggs, milk) for human consumption or for use in animal feeding.
Control area	A declared area in which defined conditions apply to the movement into, out of, and within, of specified animals or things. Conditions applying in a control area are of lesser intensity than those in a restricted area.
Dangerous contact animal	An animal showing no clinical signs of disease but which, by reason of its probable exposure to disease, will be subjected to disease control measures.
Dangerous contact premises	Premises containing dangerous contact animals.
Decontamination	Includes all stages of cleaning and disinfection.
Fomites	Inanimate objects (eg boots, clothing, equipment, vehicles, crates, packagings) that can carry the exotic agent and spread the disease through mechanical transmission.
Infected premises	A defined area (which may be all or part of a property) in which an infectious disease or disease agent exists or is believed to exist.
Premises	A defined area or structure, which may include part or all of a farm, enterprise or other private or public land, building or property.
Quarantine	Legal restrictions imposed on a place, animal, vehicle or other things limiting movement.
Rendering	Processing by heat to inactivate infective agents. Rendered material may be used in various products according to particular disease circumstances.
Restricted area	A relatively small declared area (compared to a control area) around an infected premises that is subject to intense surveillance and movement controls.
Risk enterprise	A livestock or livestock-related enterprise with a high potential for disease spread, eg an abattoir, milk factory, artificial breeding centre or livestock market.
Salvage	Recovery of some (but not full) market value by treatment and use of products, according to disease circumstances.
Stamping out	Eradication procedures based on quarantine and slaughter of all infected animals and animals exposed to infection.
Susceptible animals	Animals that can be infected with the disease .
Suspect animals	An animal that may have been exposed to an exotic or serious infectious disease such that its quarantine and intensive surveillance is warranted; OR an animal not known to have been exposed to a disease agent but showing clinical signs requiring differential diagnosis.
Suspect premises	Premises containing suspect animals.
Swill	Leftover food (kitchen and table scraps) used to feed pigs
Tracing	The process of locating animals, persons or things that may be implicated in the spread of disease, so that appropriate action can be taken.
Vector	A living organism (frequently an arthropod) that transmits an infectious agent from one host to another. A *biological* vector is one in which the infectious agent must develop or multiply before becoming infective to a recipient host. A *mechanical* vector is one that transmits an infectious agent from one host to another but is not essential to the life cycle of the agent.
Zoonosis	Disease that can affect humans as well as animals.

REFERENCES

Ford, W.B. (1994) Air curtain Incinerator^{TM} system test for disposal of large animal carcases. *Foreign Animal Disease Report*, 22-2, United States Department of Agriculture.

McDaniel, H. A. (1991). Environmental protection during animal disease eradication programmes. OIE Revue Scientifique et Technique, 10: (3): 867-884

Pryde, L.C. (1990) Slaughter and disposal of sheep. Agnote Reg 3/15, NSW Agriculture.

Training resources

First things first – slaughter and disposal of sheep, cattle and horses (video), AAHL 1993 (available from the Australian Animal Health Laboratory (AAHL), Geelong, Australia

First things first – slaughter and disposal of pigs (video), AAHL 1993 (available from AAHL)

First things first – slaughter and disposal of poultry (video), AAHL 1993 (available from AAHL)

PART 3

DECONTAMINATION PROCEDURES.

1 INTRODUCTION

Decontamination is the combination of physical and chemical processes that kills or removes pathogenic microorganisms. Decontamination to cleanse premises where infected animals have been housed and other possible fomites (i.e. contaminated objects) reduces the risk of the spread of infectious diseases to new animals. It is thus an important part of the control and eradication of major exotic or emergency livestock diseases.

The interpretation of exotic/emergency in relation to a disease depends upon the country involved. For this reason, detailed discussion in this section is confined to the OIE List A diseases, all but one of which have a viral aetiology. These diseases are considered serious even in countries where they are presently endemic, and eradication is always recommended where possible. It is recognised that many List B and even unlisted diseases have serious implications in many countries where they occur, and would have even more serious implications should they be introduced into countries presently free of them. Nevertheless, for the sake of consistency, the emphasis on this manual is on the List A diseases. The exceptions are rabies and bovine spongiform encephalopathy (BSE), List B diseases with such serious implications for human health, that they have been included.

Thorough decontamination, which involves *close cooperation* between farmers and all personnel involved in the cleaning and disinfection procedures, reduces the period between slaughter and restocking on contaminated and affected properties.
This manual provides guidelines for the decontamination of premises where animals infected with a specified disease agent have been held.

Identification of the disease agent is fundamental for designing an appropriate decontamination strategy. A sound understanding of the agent's biological properties and how the disease spreads can then form the basis for strategic planning. Importance is placed on the adoption of the basic microbiological principles of isolation of the source of infection and decontamination of personnel, equipment, vehicles and sites. Personal decontamination procedures, when properly carried out, permit the safe movement of personnel from property to property in the extensive surveillance activities that form a large and vital part of any eradication campaign. Preliminary cleaning is invariably needed before any chemical disinfectants are used and this aspect cannot be overemphasised. Mechanical brushing of surfaces with a detergent solution is highly effective in removing contaminating viruses and is fundamental for achieving subsequent effective chemical decontamination. Procedures described may appear simple and tedious, but persistence and attention to detail are vital for successful elimination of the disease agent.

This manual concentrates on a relatively narrow range of disinfectants and other chemicals in six general groups:

(1) soaps and detergents

(2) oxidising agents

(3) alkalis

(4) acids

(5) aldehydes

(6) insecticides

All the above disinfectants (1-5) are effective against a broad range of viruses. Consequently, disinfectants are recommended that are generally available in large quantities.
Note: Common chemical names are used because they are easily understood by all personnel with basic scientific knowledge. Clear instructions are given for the dilution and application of these disinfectants (see Table 4).

How to use the decontamination procedures part of the manual

The decontamination parthas a series of simple tables that clearly and simply set out information on cleaning, disinfection and safety precautions regarding specified animal disease agents.

- to check the best type of disinfectant for each virus see **Tables 1 and 4**
- to check the best type of disinfectant to use on a variety of objects for each disease see **Table**
- to understand the disease you are facing see **Figure 1**
- to understand the decontamination principles for each disease see **Table 3**
- to check the concentration and dilution of disinfectants see **Table 4**
- to check safety concerns see **Table 5**
- to read about decontamination principles see **Sections 4 and 5**

2 KNOW THE ENEMY – the emergency disease agent

In order to eliminate disease viruses/agents from clothing, vehicles, tools, carcasses or the environment, there must be a good understanding of the general properties of each infectious agent and the subtle ways each may persist in the environment and infect other animals. The following tables and graphs quickly show the individual characteristics of each disease.

The set of tables and figures presented in this section categorise the viruses and agents according to their physical characteristics to show clearly which disinfectant is best used for inactivation.

2.1 Disinfectant susceptibilities of important disease agents

The viruses/disease agents responsible for serious/emergency diseases can be categorised according to their size and whether or not they contain lipid. On this basis two categories of viruses can be identified as follows:

- *Category A* Lipid-containing viruses; intermediate to large size
- *Category B* No lipid in virus; small to intermediate size

Table 1 shows the virus families, species affected, main mode of transmission and category of the OIE List A animal virus diseases and rabies and bovine spongiform encephalopathy.

Table 1.1 Disinfectant susceptibilities of viruses

Virus family	Structure[1]	Diseases	Species affected	Trans-mission	Category of virus[2]
Asfaviridae	Large sized, dsDNA, enveloped.	African swine fever	Swine	Ingestion, contact, ticks (*Ornitho-doros*)	A
Bunyaviridae	Moderate sized, ssRNA, enveloped	Rift Valley fever[3]	Ruminants, humans, dogs	Insect vectors	A
		Nairobi sheep disease	Sheep, goats	Insect vectors	
Caliciviridae	Small-sized, ssRNA, non-enveloped	Vesicular exanthema	Swine	Ingestion	B
Orthomyxo-Viridae	Medium sized, ssRNA enveloped	Avian influenza	Avian species	Aerosols, ingestion	A
Paramyxoviridae	Medium sized, ssRNA, enveloped	Newcastle disease	Avian species	Aerosols, ingestion	A
		Rinderpest	Ruminants, swine	Aerosols, ingestion	
		Peste des petits ruminants	Small ruminants	Aerosols,ingestion	
Picornaviridae	Small sized, ssRNA, non-enveloped	Foot-and-mouth disease[3]	Ruminants, swine	Aerosols, ingestion	B
		Swine vesicular disease	Swine	Aerosols, ingestion	
Poxviridae	Large sized, dsDNA, enveloped	Sheep/goat pox	Sheep and goats	Contact, insect vectors	A
		Lumpy skin disease	Cattle		
Reoviridae	Medium sized, dsRNA, non-enveloped	African horse sickness[3]	Equidae, dogs	Insect vectors	B
		Bluetongue	Ruminants		
Rhabdoviridae	Medium sized, ssRNA, enveloped	Rabies, rabies-like viruses	All mammalianspecies	Infected animals (mainly bites)	A
		Vesicular stomatitis	Ruminants, horses, swine humans	Insect vectors	

KEY

1 ds = double stranded; ss = single stranded

2 Category A–best disinfectants are detergents, hypochlorites, alkalis, Virkon®, glutaraldehyde

Category B–best disinfectants are hypochlorites, alkalis, Virkon®, glutaraldehyde;
Acids effective for foot-and-mouth disease virus
Classical bactericides like quaternary ammonium compounds and phenolics are not effective against these viruses

Category C–these viruses fall between Categories A and B in sensitivity to the best disinfectants such as hypochlorites, alkalis, Virkon®, glutaraldehyde

3 Acidic disinfectants have traditionally been used for these pathogens.

Note: Details of concentrations and applications of specific disinfectants are found in Table 4.

Table 1.2 Diseases caused by other agents

Agent	**Disease**	**Species affected**	**Transmission**
Prion[1]	Bovine spongiform encephalopathy (BSE)	Cattle, antelopes , humans, cats	Ingestion of nervous tissue and possibly certain other tissues of infected animals; transmission in cattle possibly transplacental
Mycoplasma mycoides mycoides SC[2]	Contagious bovine pleuropneumonia	Cattle	Contact, aerosol

[1] Special inactivation is required.
[1] Decontamination is not usually necessary during a stamping out campaign for CBPP. However, if necessary, the organism is inactivated by 1% phenol solution in 3 minutes; 0.05 formaldehyde solution in 30 seconds; or 0.01% mercuric chloride solution in 1 minute.

[1] Special inactivation is required.
[2] Decontamination is not usually necessary during a stamping out campaign for CBPP. However, if necessary, the organism is inactivated by 1% phenol solution in 3 minutes; 0.05 formaldehyde solution in 30 seconds; or 0.01% mercuric chloride solution in 1 minute.

2.2 Disinfectant/chemical selections for particular viruses

Table 2 (2.1–2.15) shows how to select a disinfectant/chemical to disinfect a range of commonly contaminated items for each disease or group of diseases. The list of disinfectant groups has been kept as short and as simple as possible. Where a common decontamination/disinfection strategy is recommended, diseases are grouped. Each disinfectant table gives a list of items that could be contaminated during a disease outbreak and then lists the best disinfectants or procedures to be used on each item. The list aims to give the operator more than one choice of disinfectant.

There are five groups of disinfectants **(soaps and detergents, oxidising agents, alkalis, acids and aldehydes)**. These are explained in more detail in Section 3. The sixth group (Insecticides) only applies to diseases that are insect-vector borne.
A key to the recommended disinfectants/chemicals is shown at the end of Table 2. Diseases with similar disinfection procedures are grouped together (e.g. African swine fever and classical swine fever [2.2]).

Table 2.1 Disinfectant/chemical selections and procedures — African horse sickness

Category B virus

Item to be disinfected	Disinfectant/chemical/procedure
Live animals	Euthanase if moribund, vaccinate, insect control (stabling at night)
Carcasses	Bury or render, not for pet food
Animal housing/equipment	N/A
Environs	N/A
Humans	N/A
Electrical equipment	N/A
Water	Keep horses away from vector insect habitat (stables on high ground, insect-proof stables, stable horses from dusk until dawn)
Feed	Bury only if contaminated with blood
Effluent, manure	N/A
Human housing	N/A
Machinery, vehicles	N/A
Clothing	N/A
Aircraft	N/A

N/A = not applicable

Table 2.2 Disinfectant/chemical selections and procedures — African swine fever and classical swine fever

Category A viruses

Item to be disinfected	Disinfectant/chemical/procedure
Live animals	Euthanase (ASF) or vaccination (CSF)
Carcasses	Bury or burn
Animal housing/equipment	1, 2a, 2b or 2c, 3
Environs	Consider 6a or 6b for tick eradication, or burn wooden structures, otherwise N/A
Humans	1
Electrical equipment	5c
Water	
–tanks	Drain
–dams	N/A
Feed	Bury or burn
Effluent, manure	Bury or burn, 4, 3
Human housing	1, 2a, 2b, or 2c
Machinery	1, 3
Vehicles	1, 3
Clothing	1, 2a, 2b or 2c, 3
Aircraft	1, 2c

N/A = not applicable

Table 2.3 Disinfectant/chemical selections and procedures — Avian influenza and Newcastle disease

Category A viruses

Item to be disinfected	Disinfectant/chemical/procedure
Live birds	Euthanase or vaccination
Carcasses	Bury or burn
Animal housing/equipment	1, 2a, 2b, 2c, 3
Environs	N/A
Humans	1
Electrical equipment	5c
Water	
–tanks	Drain to pasture where possible
–dams	Drain to pasture if practicable, otherwise N/A.
Feed	Bury.
Effluent, manure	Bury or burn, 4, 3
Human housing	1, 2a, 2b, 2c
Machinery, vehicles	1, 3
Clothing	1, 2a, 2b, 2c, 3
Aircraft	1, 2c

N/A = not applicable

Table 2.4 Disinfectant/chemical selections and procedures — bluetongue

Category B virus

Item to be disinfected	Disinfectant/chemical/procedure
Live animals	Vaccination
Carcasses	Bury or burn normally, but this has no effect on virus spread
Animal housing/equipment	N/A
Environs	Decrease or keep sheep away from vector insect habitats (low-lying marshy areas)
Humans	1
Electrical equipment	N/A
Water	N/A
Feed	N/A
Effluent, manure	N/A
Human housing	N/A
Machinery	N/A
Vehicles, aircraft	6a or 6b for aircraft disinfection if necessary
Clothing	N/A

N/A = not applicable

Table 2.5 Disinfectant/chemical selections and procedures — BSE

Non-viral disease agent — prions; special inactivation necessary

Item to be disinfected	Disinfectant/chemical/procedure
Live animals	Quarantine then euthanase according to disease strategy
Carcasses	Bury with care or burn
Animal housing/equipment	Bury or burn all contaminating birth materials, manure or carcasses. 1 then 2a
Humans	Ensure that contamination does not occur – protective clothing, masks, respirators when removing the brain
Electrical equipment	N/A
Water	
–tanks, dams	N/A
Feed	Bury, burn only if contaminated with birth material, manure or carcasses
Effluent, manure	Bury/burn
Human housing	N/A
Machinery, vehicles	N/A
Clothing	Burn if heavily contaminated
Aircraft	N/A

N/A = not applicable

Table 2.6 Disinfectant/chemical selections and procedures — Foot-and-mouth disease, swine vesicular disease and vesicular exanthema

All of these vesicular diseases are **Category B viruses**.

Item to be disinfected	Disinfectant/chemical/procedure[1]
Live animals	Euthanase or vaccination
Carcasses	Bury or burn, 3, 4
Animal housing/equipment	2, 3
Environs	3
Humans	1, 4b
Electrical equipment	5c
Water	
–tanks, dams	3
Feed	Bury or 5b
Effluent, manure	Bury or 4
Human housing	2, 4b
Machinery	2c, 3, 4
Vehicles	2c, 3, 4
Clothing	2, 2c, 3, 4b
Aircraft	2c

1 = Acids are usually preferred for FMDV

Table 2.7 Disinfectant/chemical selections and procedures — lumpy skin disease and sheep and goat pox

Category A viruses

Item to be disinfected	Disinfectant/chemical/procedure
Live animals	Euthanase or vaccination (LSD)
Carcasses	Bury or burn
Animal housing/equipment	1 (to clean) followed by 2, or 3 or 4b or 5
Environs	2 or 3 or 4b
Humans	1, 2, 3b or 4b
Electrical equipment	5c
Water	
–tanks, dams	Decrease vector insect habitat
Feed	Bury or burn
Effluent, manure	Bury and 6a or 6b for insect control
Human housing	1 followed by 2, 3 or 4b
Machinery, vehicles	1 followed by 2, 3 or 4b
Clothing	Destroy if not valuable, or 2, 3 or 4b
Aircraft	1 followed by 2 or mild 3, or 4b

N/A = not applicable

Table 2.8 Disinfectant/chemical selections and procedures — peste des petits ruminants and rinderpest

Category A viruses

Item to be disinfected	Disinfectant/chemical/procedure
Live animals	Euthanase or vaccination
Carcases	Bury or burn
Animal housing/equipment	1 (to clean) followed by 2a, 2b, 2c or 3 if necessary
Environs	2 or 3
Humans	1, 2c or 4b
Electrical equipment	5c
Water	
– tanks, dams	Drain to pasture where possible
Feed	Bury contaminated feed
Effluent, manure	2, 3, 4 then bury
Human housing	1 (to clean) followed by 2a, 2b, 2c or 3 if necessary
Machinery, vehicles	1 (to clean) followed by 2a, 2b, 2c or 3 if necessary
Clothing	1 (to clean) followed by 2a, 2b, 2c or 3 if necessary
Aircraft	1 (to clean) followed by 2a, 2b, 2c or 3 if necessary

N/A = not applicable

Table 2.9 Disinfectant/chemical selections and procedures — rabies

Category A virus

Item to be disinfected	Disinfectant/chemical/procedure
Live animals	Destroy without, if possible, damaging head. Beware of being bitten.
Dead animals	Submit head to a rabies diagnostic laboratory in an appropriate infectious goods container for confirmation of infection. Burn or bury the remainder of the carcass.
Animal housing/equipment	1 (to clean) followed by 2
Environs	N/A
Humans	Bites should be thoroughly washed with 1 then cleaned with a disinfectant suitable for human wounds. The offending animal should be euthanased and the head sent for confirmation of infection. Unless the animal can be conclusively shown to be free from infection, a post-exposure course of human diploid cell vaccine (HDCV) and human immunoglobulin (RIGH) should be started.
Electrical equipment, machinery	N/A
Water	
– tanks, dams	N/A
Feed,	N/A
Effluent/manure	Burn or bury
Human housing, clothing	N/A
Vehicles, aircraft	N/A

N/A = not applicable

Table 2.10 Disinfectant/chemical selections and procedures — Rift Valley fever

Category A virus

Item to be disinfected	Disinfectant/chemical/procedure
Live animals	Quarantine, then decrease insect vectors 6a or 6b
Carcasses	Bury or burn. Take extreme care and guard against blood splash, aerosols, fomites contacting humans
Animal housing/equipment	1 (to clean) followed by 2 or 4
Environs	2 or 4 and insect control 6a or 6b
Humans	2c or 4b
Electrical equipment	5 if necessary
Water	
–tanks, dams	Decrease vector insect habitat
Feed	Bury feed contaminated by blood, aerosols, fomites
Effluent/manure	Drain to pit/bury and 6a or 6b for insect control
Human housing, clothing	1 (to clean) followed by 2 or 4
Machinery, vehicles	1 (to clean) followed by 2 or 4
Aircraft	1 (to clean) followed by 2 or 4

Table 2.11 Disinfectant/chemical selections and procedures — vesicular stomatitis

Category A virus

Item to be disinfected	Disinfectant/chemical/procedure
Live animals	Treat those in buffer zone with 6c (to prevent insects breeding in manure) and 6a or 6b (to prevent insects biting)
Carcasses	Bury or burn
Animal housing/equipment	6a, 6b (to kill insects) 1 (to remove virus) 2, 3 also effective
Environs	6a
Humans, clothing	1
Electrical equipment	5c
Water	
–tanks, dams	Drain to pasture where possible; decrease vector insect habitat
Feed	6d
Effluent, manure	Bury or 6a
Human housing	6a, 6b (to kill insects) 1 (to remove virus)
Machinery, vehicles, aircraft	6b (to kill insects) 1 (to remove virus)

KEY to Tables 2.1 – 2.14

1 Soaps and detergents

2 Oxidising agents:
- **a**. Sodium hypochlorite
- **b**. Calcium hypochlorite
- **c**. Virkon®

3 Alkalis:
- **a**. Sodium hydroxide (caustic soda)(NaOH); — Do not use with aluminium and like alloys
- **b**. Sodium carbonate anhydrous (Na_2CO_3) washing soda ($Na_2CO_3.10H_20$)

4 Acids:
- **a**. Hydrochloric acid
- **b**. Citric acid

5 Aldehydes:
- **a**. Glutaraldehyde — Glutaraldehyde is not too corrosive on metals but must not be used on humans and animals
- **b**. Formalin
- **c**. Formaldehyde gas — Gaseous formaldehyde is dangerous and subject to error; it should only be used by experienced personnel and in controlled conditions

6 Insecticides:
- **a**. Organophosphates
- **b**. Synthetic pyrethroids
- **c**. Ivermectin
- **d**. Phostoxin

2.3 Epidemiological considerations affecting decontamination procedures for particular viruses

Table 3 (3.1-16) summarises epidemiological factors that govern the extent of procedures to be employed in removing the disease agent. NB. The recommended disinfectants and chemicals applicable to elimination of each disease agent are listed in Tables 2.1–2.14 and appropriate procedures are in Sections 3, 4 and 5.

Table 3.1 Epidemiological considerations — African horse sickness

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	A peracute, acute,subacute or mild insect-borne viral disease affecting mainly Equidae. Horses are most susceptible, mules less so and in donkeys disease is usually subclinical. Dogs also susceptible REOVIRIDAE (CATEGORY B VIRUS) with 9 known serotypes Optimal pH for survival of the virus is 7.0–8.5 Resistant to detergents. Acid disinfectants most suitable for decontamination	*See* disinfectants applicable to Category B viruses (Section 3) *see* Table 2.1
Incubation period	Usually 5–7 days, may be as short as 2 days. Incubation periods up to 21 days have been recorded, but longer than 10 days is rare	Decontamination procedures are determined by an incubation period of 40 days (OIE Code)
Transmission	Transmitted between susceptible animals by biting midges. Dogs can become infected by eating infected fresh uncooked horse meat	
Airborne spread	There is no aerosol spread of AHS. There may be wind-borne spread of infected vectors	
Persistence in the environment	Virus stable outside the host Not destroyed by putrefaction and may retain infectivity in putrid blood for more than 2 years	*see* Section 4
Wildlife	Zebras are highly resistant to the pathogenic effects of the disease *{In this and subsequently: there is no reason why feral domestic species should differ greatly in susceptibility from their captive cohorts, and "wildlife" has a totally different implication}*	
Arthropod vectors	Biting midges of the family *Culicoides* are the most important vectors. Experimentally three species of mosquitoes, the brown dog tick and the camel tick have transmitted the virus	*see* Section 3
Zoonosis	Humans are not affected	

Table 3.2 Epidemiological considerations — African swine fever

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	A highly contagious, peracute, acute or (rarely) subacute viral disease of pigs	See disinfectants applicable to Category A viruses (Section 3) Detergents, oxidising agents and alkalis are the disinfectants of choice
	ASFAVIRIDAE (CATEGORY A VIRUS)	
	Virus stable over wide pH range from pH 4–10	
Incubation period	Incubation period 5–15 days	Decontamination procedures are determined by an incubation period of 40 days (OIE Code)
Transmission	ASF virus is excreted by infected domestic pigs in faeces, urine, and all secretions in high concentration	
	Virus is transmitted readily by direct contact or ingestion of infected pig meat e.g. by swill feeding or scavenging	
	Recovered animals will retain virus for 2 – 6 months	
	Transfer by fomites e.g. infected vehicles, contaminated clothing, needles	
Airborne spread	Not a factor, can occur over very short distances (same pen)	
Persistence in the environment	Pigs that recover from ASF may remain carriers and may shed virus for up 2 months.	*see* Section 4
	Virus survives for long periods in a protein environment: in serum at room temperature for 18 months, in refrigerated blood for at least 6 years, at 37°C for a month and at 55°C for 30 minutes, in raw and processed meat for several weeks to months, especially if frozen,	
	Resistant to putrefaction, with persistence in faeces at room temperature for 11 days and decomposed serum for 15 weeks	
	Pig pens in the tropics without disinfection were safe after 5 but not 3 days	
Wildlife	All African wild porcines (warthogs, bush pigs, giant forest hogs) are susceptible to infection but completely resistant to the pathogenic effects of the virus, and act as reservoir hosts in the sylvatic cycle	
	European wild boar are fully susceptible and mortality rates are similar to those of domestic pigs	
Arthropod vectors	Sylvatic life cycle between warthogs and *Ornithodoros moubata* complex ticks, which can transmit virus to domestic pigs. A cycle between *Ornithodoros* and domestic pigs occurs in some areas	Where applicable, identify tick species and spray defined area with insecticide
	Mechanical transmission can occur by stable flies for 24 – 48 hours after ingestion of infected blood; other blood-sucking pig parasites may be implicated in the spread of ASF within pig herds but this is unproven	
Zoonosis	Humans are not affected	

Table 3.3 Epidemiological considerations — avian influenza (fowl plague)

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	A highly contagious generalised viral disease of poultry and other birds ORTHOMYXOVIRIDAE (CATEGORY A VIRUS) with strains of varying virulence. Virus is relatively stable but is rapidly inactivated at extremes of pH	See disinfectants applicable to Category A viruses (Section 3) see Table 2.4
Incubation period	Incubation period is variable from a few hours to 3 days	Decontamination procedures are determined by an incubation period of 21 days (OIE Code)
Transmission	Virus is shed from the respiratory tract and in faeces for 30 days post infection in recovered birds The disease spreads rapidly within the flock by direct contact Indirect spread occurs via contaminated people, articles, feed and vehicles	
Airborne spread	Rapid within the flock but is not important between flocks	*see* Section 3
Persistence in the environment	Remains viable in water and faeces for 32 days and under a wide variety of environmental conditions at pH 7–8	*see* Section 4
Persistence in products	AI virus survives only a few days in carcasses at ambient temperatures and up to 23 days when refrigerated Packaging and drip from infected carcasses can be contaminated with virus Eggs laid in the early phase of disease could have AI virus in albumen, yolk and on the surface AI virus can penetrate intact egg shell and has been isolated from fertile eggs Poultry offal meals should be rendered but recontamination could be a problem	
Arthropod vectors	Not applicable	
Wild birds	Water fowl and many species of wild birds are reservoirs for the virus, without showing significant disease, and the opportunity exists for mutation of virus to virulent pathogenic strains	
Zoonosis	Humans were until recently not thought to be affected, but recently cases in humans, some fatal, have been diagnosed	

Table 3.4 Epidemiological considerations — bluetongue

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	Arthropod-borne viral disease of mainly sheep, goats and deer REOVIRIDAE (CATEGORY C VIRUS) 24 serotypes comprising countless strains of varying virulence Infection of cattle, although usually subclinical, is of great epidemiological significance Unstable below pH 6.5 and at high temperatures, readily inactivated by acid and alkaline disinfectants	There are no requirements for any procedures to be employed
Incubation period	About 7 days with natural infection, 2 – 15 but usually 4 – 6 days with experimental infection	

Transmission	Not contagious, transmission mainly by arthropod vector, but may be transmitted in semen or transplacentally by viraemic animals	
Arthropod vectors	The disease is transmitted by biting midges (*Culicoides* spp.) Cattle are the main amplifying hosts	Disinsection would be impractical in most circumstances *see* Table 2.5
Airborne spread	Aerosol spread is not a factor, but wind-borne spread by aerial drift of infected *Culicoides* spp. may occur	
Wildlife	African antelopes do not develop clinical disease and may act as amplifying hostsSevere disease is reported in desert bighorn sheep	
Zoonosis	Humans are not affected	

Table 3.5 Epidemiological considerations — Bovine spongiform encephalopathy

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	A transmissible spongiform encephalopathy of cattle caused by an unconventional agent. PRION (SPECIAL INACTIVATION REQUIRED) Disinfectants are not effective Reported in domestic cats; other species can be infected experimentally	*see* Table 2.6
Incubation period	Prolonged, (2 years ior more in cattle); most cases occur in cattle aged between 3 and 7 years	OIE Code does not specify a maximum incubation period.
Transmission	Ingestion of contaminated carcass meal that contains nervous tissue from affected animals or possibly sheep with scrapie	
Airborne spread	Not applicable	
Persistence in the environment	Can persist for very long periods in the environment (presumed to act in similar way to scrapie agent)	
Wildlife	Spongiform encephalopathies have been reported in antelopes in British zoos and in large and small cats	
Arthropod vectors	Not applicable	
Zoonosis	There is convincing evidence that the BSE agent causes a fatal transmissible encephalopathy, new variant Creuzfeld-Jakob disease, in humans	

Table 3.6 Epidemiological considerations — classical swine fever (hog cholera)

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	Contagious acute, subacute, chronic or inapparent viral disease of pigs	*See* disinfectants applicable to Category A viruses (Section 3)
	TOGAVIRIDAE (CATEGORY A VIRUS) strains of varying virulence	*see* Table 2.2
	Virus is stable at pH 4–10 but rapidly inactivated below pH 3, relatively heat stable but sensitive to desiccation, ultraviolet light and putrefaction	
	Virus is relatively heat stable but is sensitive to desiccation, ultraviolet light and putrefaction	
Incubation period	Incubation period for acute disease usually 2 - 6 days	Decontamination procedures are determined by an incubation period of 40 days (OIE Code) and by epidemiology
Transmission	Disseminated mainly by direct contact with infected pigs. Infected pigs excrete virus in faeces, urine, nasal and lachrymal secretions. Virus is shed before clinical signsare seen	
	The disease can spread rapidly within pig populations	
	Carrier sows can infect piglets transplacentally and large amounts of virus are shed at farrowing	
	Spread by movement of infected pigs via sales, fomites and contaminated vehicles	
	Feeding of swill	
	Multiple use of hypodermic needles and vaccine	Discard needles and partially used bottles
Airborne spread	Not applicable	
Persistence in the environment	Sensitive to ultraviolet radiation and will survive in contaminated pig pens only a few days	*see* Section 4
Persistence in products	Pigmeat products can maintain the virus for up to 2–4 months in salted or brined meat	
	Pork products (fresh and frozen) can maintain infective CSF virus for months if kept cool and years if frozen, 2 – 4 months in salted or brined pork	
Wild animals	European wild boar are an important reservoir host of the virus	
Vectors	Generally unimportant. Mosquitoes and two species of stable fly have been shown capable of mechanically transmitting CSF virus	
Zoonosis	Not applicable	

Table 3.6 Epidemiological considerations — contagious bovine pleuropneumonia (CBPP)

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	Acute,subacute or chronic disease of cattle and water buffaloes *Mycoplama mycoides* subsp. *Mycoides* SC (bovine biotype). The mycoplasma has a low resistance to environmental factors and only survives outside the host for less than three days in tropical conditions and less than two weks in temperate conditions.	Decontamination procedures are generally not necessary in stamping out campaigns for CBPP
Incubation period	Generally 3-6 weeks but may be as long as four months	
Transmission	Disseminated by direct contact with infected cattle or water buffaloes. Infection is contracted by inhalation of infected droplets Chronic carrier animals are very important for persistence of the disease in an area and for its spread to new areas.	
Airborne spread	Very important over short distances	
Persistence in the environment	The mycoplasma has a low resistance to environmental factors and only survives outside the host for less than three days in tropical conditions and less than two weks in temperate conditions	
Persistence in products	Not applicable	
Wild animals	Yaks and bison are susceptible. Antibodies have been found in some other species (e.g. camels and water buffaloes) but their significance is doubtful	
Vectors	Not applicable	
Zoonosis	Not applicable	

Table 3.7 Epidemiological considerations — foot-and-mouth disease

DISEASE STRATEGIES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	Highly contagious, viral, vesicular disease of cloven-footed animals	*See* disinfectants applicable to Category B viruses (Section 3) Acid, alkali and chlorine-based disinfectants can be used (provided CARE is taken that they are not mixed together) *see* Table 2.8
	PICORNAVIRIDAE (CATEGORY B VIRUS) 7 serotypes with 60 + subtypes	
	The virus is varyingly stable at pH 6.7–9.5; rapidly inactivated below pH 5 and above pH 11	
	The virus is stable at low temperatures and when the relative humidity is above 60%	
	The virus is moderately susceptible to ultraviolet light and rapidly inactivated at temperatures above 50°C	
Incubation period	Incubation period USUALLY 3–5 days	Decontamination procedures are determined by an incubation period of 14 days (OIE Code)
	FMD virus is excreted 1–5 days prior to clinical signs depending on incubation period	
Transmission	Virus is excreted from nasal passage, saliva, milk, semen, faeces, urine and in vast amounts from ruptured vesicles	All procedures listed in this manual should be observed. Personal decontamination is important (*see* Section 4)** Preliminary pre slaughter spraying should be carried out especially in piggeries and enclosed animal houses
	Pigs excrete up to 3000 times more virus than other animals	
	The disease is rapidly spread by direct contact especially at shows and sales	
	Indirect contact with contaminated people, fomites, milk, manure vehicles and illegal swill feeding is well documented	
	Cattle remain carriers for at least 27 months, sheep for 9 months but pigs are NOT long-term carriers	
Persistence in the environment	FMD virus may remain infective in the environment for several weeks, possibly longer in the presence of soil, manure, dried animal secretions, straw, hair and leather	*see* Section 4
Persistence in products	FMD virus is inactivated in 'setting' meat (NOT pigmeat) but is NOT inactivated in offal, bone marrow, lymph nodes and blood clots	These facts determine the extent of operations following tracing of stock during a disease outbreak
	FMD virus survives in salted/cured meats, hides milk, dairy products, wool and semen	
Airborne spread	Can be extremely widespread over long distances if conditions of temperature, wind speed, humidity, terrain, atmosphere and viral concentration are right. Cattle are usually the INDICATOR since they ventilate 10 x more air than other species	Preliminary spray of buildings
Wildlife	Feral and wild animals have potential to be an important risk in perpetuating or disseminating FMD virus	
Arthropod vectors	Not applicable. Mechanical transfer could occur.	

Zoonosis	Very rarely zoonotic. It is known to cause vesicles on hands and lips Human nasal passages can mechanically harbour the virus for 24–27 hours despite masks and noseblowing	If a person is affected, they must NOT have contact with susceptible animals until cleared of infection Recommend no contact with susceptible stock for 72 hours

****Note: Where light contamination has occurred, especially in dry, hot areas the intensity of decontamination necessary can be assessed by the local disease control centre (LDCC).**

Table 3.8 Epidemiological considerations — lumpy skin disease

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	An acute highly infectious skin disease of cattle. POXVIRIDAE (CATEGORY A VIRUS) Inactivated after heating for 1 hour at 55°C. Susceptible to a wide range of disinfectants	*See* disinfectants applicable to Category A virus (Section 3). *see* Table 2.9
Incubation period	In naturally-infected animals incubation period is 2–4 weeks; in experimental infections 5 days	Decontamination procedures are determined by an incubation period of 21 days (OIE Code).
Transmission	Mostly the result of insect transmission, with many types of biting insects implicated. The virus could be transmitted in milk, semen, blood and lesions in cattle hides	
Airborne spread	Wind-borne spread of the insect vector only	
Persistence in the environment	The virus is very resistant and can remain viable for long periods on or off the animal host It survives well at cold temperatures but is susceptible to sunlight	
Wildlife	Vermin, predators and wild birds might act as mechanical carriers of the virus	
Arthropod vectors	Stable and blow flies are important in spread. Biting insects such as mosquitoes, midges and tse-tse fly may play some role in the spread.	
Zoonosis	Humans are generally regarded as being non-susceptible	

Table 3.9 Epidemiological considerations — Newcastle disease (fowl pest)

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	Highly contagious, generalised, viral disease of domestic poultry, cage birds, wild birds PARAMYXOVIRIDAE (CATEGORY A VIRUS) strains vary in virulence. VELOGENIC (high) MESOGENIC (moderate) LENTOGENIC (low)	*See* disinfectants applicable to Category A viruses (Section 3)
Incubation period	Incubation period 2–6 days but can be as long as 15 days	Decontamination procedures are determined by an incubation period of 21 days (OIE Code)
Transmission	Depending on viral strain birds can die without showing symptoms Virus is shed via respiratory tract and in faeces and is rapidly spread in the flock Disease disseminated by direct contact and "carrier" state birds up to 120 days after infection Indirectly by contaminated people, articles, fomites, manure, feed and vehicles	Preliminary aerial spray of buildings
Airborne spread	Given the right environmental conditions ND virus has been known to disseminate over a wide area	Close down fans and ventilators. Preliminary aerial spray of building interior
Persistence in the environment	Virus is inactivated by heat and direct sunlight (30 minutes) but can remain 21 days in cool weather in poultry litter and sheds	
Persistence in products	Viable virus remains in the carcasse until decomposition is well advanced Isolated from bone marrow after several days at 30°C Virus will remain viable in carcasse meat for more than 250 days at 14°C Eggs laid in the early phase could contain ND virus on the surface; egg pulp likely to be infected	Procedures for decontamination of buildings, hatcheries, slaughter houses as above
Wild birds	Could be reservoir, become infected in an outbreak or transmit mechanically — 'carrier' state can exist up to one year	
Arthropod vectors	'Flies' are thought to transmit ND virus mechanically	
Zoonosis	Headache and flu-like symptoms can occur in humans. Conjunctivitis usually mild but can occasionally become severe and cause impairment of vision. It is suspected that person- to-person transmission may occur	Infected people to have no contact with susceptible stock until cleared of virus

Table 3.10 Epidemiological considerations — rabies

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	An almost invariably fatal viral encephalitis affecting all warm blooded mammals RHABDOVIRIDAE (CATEGORY A VIRUS)	See disinfectants applicable to Category A viruses (Section 3)
Incubation period	Incubation period is very variable from 4 days to 6 months or more depending on a number of factors Virus can be excreted in saliva up to 7 days prior to symptoms appearing	Incubation period is not a determinant of decontamination procedures, more from initial clinical signs (OIE Code maximum incubation period is 6 months)
Transmission	Rabies virus is transmitted directly by the bite of a rabid animal or contamination of a fresh wound with infected saliva or contamination of mucous membranes Virus cannot invade intact skin Respiratory and oral transmission can occur exceptionally	When a known rabid animal has dripped saliva, the immediate environment can be disinfected for cosmetic reasons or to allay public concern
Airborne spread	Not applicable except in an extreme situation (as above)	
Persistence in the environment	Rabies virus is fragile outside the host and is not viable for long. Environmental contamination is of very little significance other than aerosol contamination in bat caves Rabies virus is inactivated by exposure to sunlight and temperature above 56°C	Personnel must be made aware of the danger of viral contamination if handling rabid animals and they must be fully aware of personal decontamination procedures
Persistence in products	Milk from rabid cows contains virus but obviously will not be used for human consumption. If milk from incubating cows is processed pasteurisation will kill the virus	
Vectors	Not applicable	
Wildlife	Could definitely be a problem with all warm-blooded animals	
Zoonosis	Most important and can arouse hysteria in human population	Initial first aid is to scrub wound with hot water and soap

Table 3.11 Epidemiological considerations — Rift Valley fever

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	An acute insect-borne viral disease affecting mainly ruminants and humans. BUNYAVIRIDAE (CATEGORY A VIRUS) Virus very susceptible to acid pH and readily inactivated below pH 6.2. Most stable within pH 7–8	*See* disinfectants applicable to Category A viruses (Section 3) *see* Table 2.12
Incubation period	Usually 2–6 days	Decontamination procedures are determined by an incubation period of 30 days (OIE Code)
Transmission	Predominantly a vector-borne disease. Aerosol transmission an important means of spread to humans as is contact with infected carcasses	
Airborne spread	Windborne dispersal of infected vectors is a means of spread of RVF.	*see* Section 3
Persistence in the environment	The virus is destroyed by strong sunlight/ultraviolet radiation Stable in aerosol form at 24°C and relative humidities of 50%–85% Can survive in dried blood for up to 3 months	
Wildlife	Species most likely to harbour the virus are goats, camels and buffalo	
Arthropod vectors	Major vectors are certain species of mosquitoes. Ticks and biting midges have been implicated.	
Zoonosis	Humans can be affected	*see* Section 4

Table 3.12 Epidemiological considerations — rinderpest/peste des petits ruminants (PPR)

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	Contagious generalised viral disease mainly of cattle (usually fatal) PPR mirrors rinderpest in all respects but is specific to sheep and goats; Asian pigs are more susceptible to rinderpest than European pigs PARAMYXOVIRIDAE (CATEGORY A virus) PPR virus is stable between pH 7.2–7.9 but is rapidly inactivated at pH values less than 5.6 or greater than 9.6	*See* disinfectants applicable to Category A viruses (Section 3) *see* Table 2.10
Incubation period	2–6 days but may be as long as 15 days Virus appears in blood excretions and secretions 1–2 days before clinical signs	Decontamination procedures are determined by an incubation period of 21 days (OIE Code)
Transmission	Transmission is via the respiratory tract and close contact. Virus present in saliva, faeces, urine, milk and products of abortion In the few animals that do recover, there is no carrier state as such but milk may be infectious 45 days after clinical recovery Disease transmitted by movement of cattle and indirectly by contaminated clothing articles and vehicles though not very likely due to low persistence of virus in environment	Suggest that preliminary disinfection and clean up only is done
Airborne spread	Is possible over several hundred metres, mainly at night. High and low humidity aid survival but virus rapidly destroyed at relative humidity 50–60%	No action if control measures in place
Persistence in the environment	Rinderpest/PPR virus is not very stable and does not survive more than two or three days Because of viral emission, saleyards and abattoirs could be contaminated Contaminated pastures would be non-infective after 6–24 hours depending on shading	
Persistence in products	Rinderpest/PPR virus is rapidly inactivated by putrefaction. 'Setting' meat would be expected to inactivate the virus	
Wild animals	Buffalo, feral cattle probably deer depending on stock density and degree of contact. Feral pig should not be a problem but Asian pigs and warthog can be affected	
Arthropod vectors	Not considered applicable	
Zoonosis	Humans are not affected	

Table 3.13 Epidemiological considerations — Sheep and goat pox

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	A highly contagious viral disease of small ruminants POXVIRIDAE (CATEGORY A VIRUS) Susceptible to a wide range of disinfectants including detergents Inactivated after heating for 1 hour at 55°C	See disinfectants applicable to Category A viruses (Section 3) *see* Table 2.9
Incubation period	Usually 12 days but varies from 2 to 14 days	Decontamination procedures are determined by an incubation period of 21 days (OIE Code)
Transmission	Most transmission is by direct contact via the respiratory system. Contact and mechanical transmission by insects can occur	
Airborne spread	Short distance aerosol transmission from nasal secretions and saliva is an important method of spread	
Persistence in the environment	The virus is very resistant and can remain viable for long periods on or off the animal host Virus susceptible to sunlight but survives well at cold temperatures May persist for up to 6 months in a suitable environment	
Wildlife	Feral goats would pose a risk and vermin, predators and wild birds might act as mechanical carriers	
Arthropod vectors	Insects can act as mechanical vectors over short distances	
Zoonosis	Humans are generally regarded as not being susceptible	

Table 3.14 Epidemiological considerations — swine vesicular disease

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	Contagious viral disease of pigs clinically indistinguishable from FMD PICORNAVIRIDAE but an ENTEROVIRUS (CATEGORY B VIRUS) The virus is very resistant to inactivation and is stable over a pH range of 2–12 Relatively resistant to heating and drying	*See* disinfectants applicable to Category B viruses (Section 3) *see* Table 2.8
Incubation period	Incubation period 2–7 days	Decontamination procedures are determined by incubation period of 28 days (OIE Code)
Transmission	Virus excreted from ruptured vesicles for up to 10 days and in faeces for more than 3 weeks but a prolonged "carrier" state does not occur Spread by direct contact between animals Indirect spread by contaminated vehicles, fomites, people and illegal swill feeding Recrudescence of disease is well known	All procedures in the Decontamination manual pertaining to contaminated persons buildings, vehicles and articles must be rigorously pursued
Persistence in the environment	Can survive in pig faeces at least 5 months	
Persistence in products	Survives in salami and frozen carcases more than one year and in intestinal casings for at least 780 days The virus is NOT destroyed by 'setting' meat	
Airborne spread	Not a factor. Aerial drift can occur over short distances due to mechanical effluent spreading	
Wildlife	Feral pigs could be a problem especially if allowed access to piggeries dumps of discarded food waste or effluent run off. Progress of the disease in feral pigs is unknown but probably would be erratic	
Arthropod vectors	Not applicable. Mechanical transfer by flies and cockroaches is minimal	
Zoonosis	Not a factor but slight zoonotic capability is suspected	No action unless a suspect case is reported. Most likely to occur in staff highly exposed to lesions in an infected premises

Table 3.15 Epidemiological considerations — vesicular exanthema

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	Acute, contagious viral disease of pigs and marine mammals	*See* disinfectants applicable to Category B viruses (Section 3)
	CALICIVIRUS (CATEGORY B VIRUS) several different serotypes varying in virulence	
	Virus mutates readily	*see* Table 2.8
	Marine mammals probably natural reservoir	
	Virus is reasonably resistant to inactivation. It is inactivated at or below pH 3 and above pH 9	
Incubation period	In natural outbreaks, 1–3 days (12 hours–12 days)	Decontamination procedures are determined by an incubation period of 28 days (OIE Code) as no OIE code exists for VE
	Virus is shed 12 hours before vesicles appear	
Transmission	Virus is shed in large quantities from ruptured vesicles. Faeces and urine do NOT appear to be infected	
	Illegal feeding of swill is primary cause of spread	
	Feeding contaminated fishmeal would be important	
	Spread by direct contact and movement of infected pigs	
	Mechanical spread by way of infected articles is inconsistent, but cannot be ignored	
Persistence in the environment	Viral persistence in environment is uncertain but contaminated premises would be at risk for 3–4 months	
Persistence in products	Contaminated pigmeat remains infectious for 4 weeks at 7°C and for years when deep frozen. Cooking at 84°C under pressure does not destroy infectivity	
Airborne spread	Not a factor	
Wildlife	Feral pigs could be a problem in an outbreak. Feral pigs scavenging the shoreline could possibly pick up infection but the world distribution is centred on the west coast of America.	
Arthropod vectors	Not applicable. Blood-sucking pig parasites may spread disease in acute phase within the pig herd	
Zoonosis	Humans are not affected	

Table 3.16 Epidemiological considerations — vesicular stomatitis

DISEASE FEATURES	EPIDEMIOLOGY	COMMENTS
Aetiology/general properties	A contagious viral disease of cattle pigs horses and possibly sheep and goats RHABDOVIRIDAE (CATEGORY A VIRUS) two distinct serotypes - Indiana and New Jersey	See disinfectants applicable to Category A viruses (Section 3)
Incubation period	Incubation period in natural outbreaks 1–3 days but can vary to 10 days	Decontamination procedures are determined by an incubation period of 21 days (OIE Code)
Transmission	Virus is shed in vesicular fluid and saliva for a few days only and has not been isolated from faeces and urine nor from saliva after lesions have healed Spread by direct contact The carrier animal state has NOT been demonstrated Much of the epidemiology is unresolved Domestic animals are probably NOT the primary host. The virus only enters through damaged skin and mucous membranes. Transmission enhanced by poor quality food (which may damage mucous membranes) Spread indirectly by fomites and people	Decontamination procedures would be limited to a preliminary disinfection and clean up.
Persistence in the environment	The virus is not very stable and survives no more than several days in premises	
Persistence in products	Virus is NOT found in edible animal tissue and would be destroyed by pasteurisation	
Airborne spread	Not applicable	
Wild animals	In endemic areas many wild life species are susceptible, eg deer, rodents, bats, feral pigs (rabbits ferrets, cats experimentally); dogs appear resistant. Wild animals may act as reservoirs	
Arthropod vectors	VS virus has been isolated from sandflies, mosquitoes gnats and flies. They are probably involved in transmission both by bite and mechanically (Indiana strain)	Disinsection would more than likely be impractical
Zoonosis	YES; human infection via the respiratory tract and conjunctiva and through skin abrasions. Disease symptoms similar to influenza	Infected humans should have no contact with susceptible stock

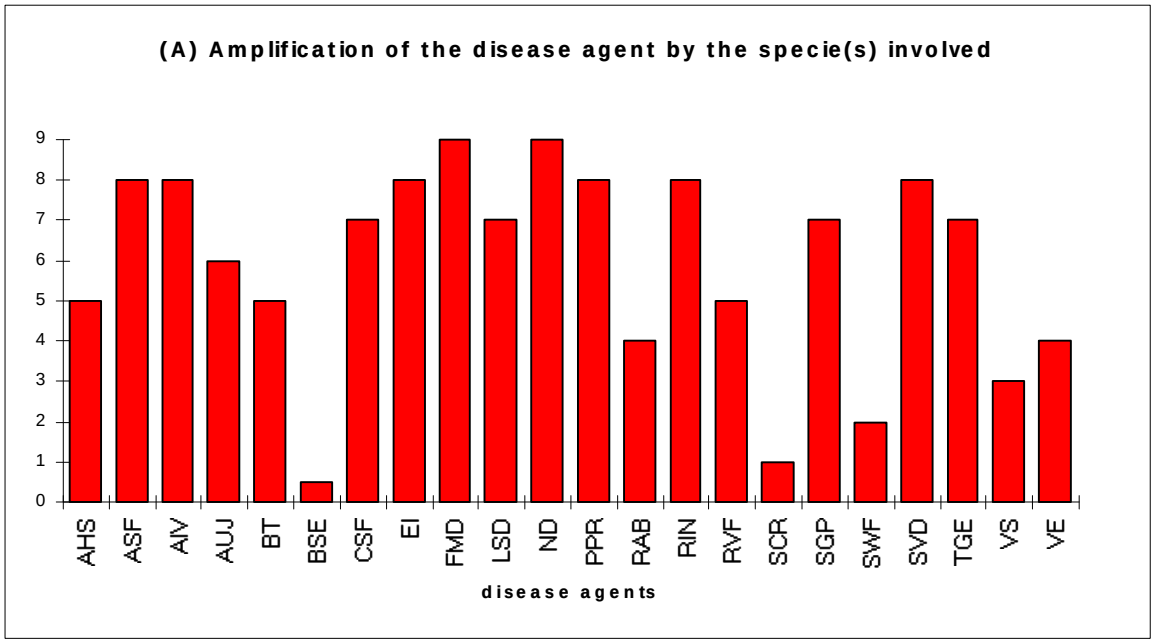
2.4 Comparison of amplification, persistence and resistance of important infectious animal disease agents

Figure 1 compares important animal disease agents using three parameters relating to decontamination principles:

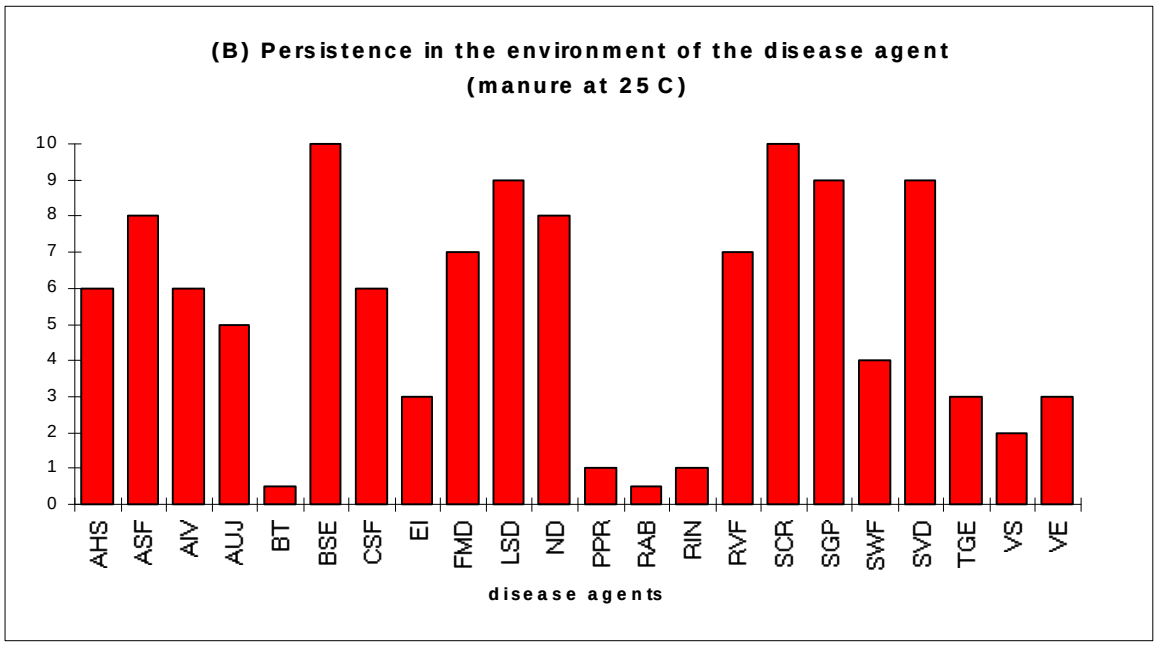
- amplification and release of the disease agent by the species involved;
- persistence in the environment of the disease agent (manure at 25°C); and
- resistance of the disease agent to inactivation.

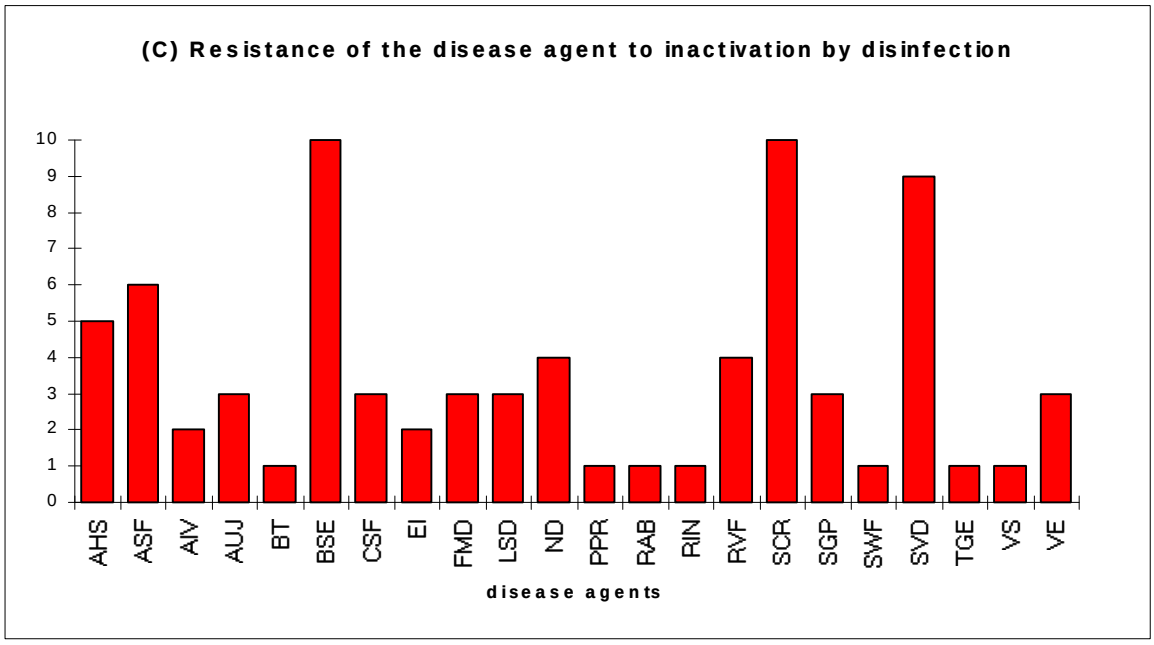
In the figure each of three parameters is given a qualitative grade from 0–10. The higher the grading the more difficult it is to eliminate the disease agent from the environment.

Figure 1 Comparative histograms for important infectious animal disease agents showing (A) amplification; (B) persistence; and (C) resistance



AHS= African horse sickness
AI= avian influenza
ASF= African swine fever,
AUJ= Aujeszky's Disease
BSE= bovine spongiform encephalopathy
BT = bluetongue
CSF= classical swine fever
EI= equine influenza
FMD =foot-and-mouth disease
LSD= lumpy skin disease
ND= Newcastle disease
PPR= peste des petits ruminants
RAB= rabies
RIN= rinderpest
RVF= Rift Valley fever
SCR= scrapie
SGP= sheep/goat pox
SVD= swine vesicular disease
SWF= screw-worm fly
TGE= transmissible gastroenteritis
VE= vesicular exanthema
VS= vesicular stomatitis


(B) Persistence in the environment of the disease agent
(manure at 25 C)
10
9
8
7
6
5
4
3
2
1
0
AHS
ASF
AIV
AUJ
BT
BSE
CSF
EI
FMD
LSD
ND
PPR
RAB
RIN
RVF
SCR
SGP
SWF
SVD
TGE
VS
VE
disease agents


(C) Resistance of the disease agent to inactivation by disinfection
10
9
8
7
6
5
4
3
2
1
0
AHS
ASF
AIV
AUJ
BT
BSE
CSF
EI
FMD
LSD
ND
PPR
RAB
RIN
RVF
SCR
SGP
SWF
SVD
TGE
VS
VE
disease agents

3 WEAPONS – disinfectants/chemicals for inactivation of exotic viruses and disease agents

3.1 Introduction

This section provides direct advice for the decontamination of premises where animals infected with a serious epidemic disease have been held. Most such diseases are caused by viruses and so the recommendations provided here are based accordingly.

3.1.1 Decontamination

Decontamination is the combination of physical and chemical processes which kills or removes pathogenic microorganisms, but does not necessarily result in sterility. A disinfectant is a chemical or mixture of chemicals capable of killing pathogenic microorganisms associated with inanimate objects.

3.1.2 Basic assessments

The most important initial information is the presumptive identification of the disease agent involved. Once established, the basic properties of the agent (most likely a virus) must be considered. What are the epidemiological characteristics of the spread of the virus? Has transmission occurred by aerosol spread, oral ingestion, close contact or insect vectors? From the information gathered, a plan can be devised to establish priorities for decontamination (Prince et al 1991). Such a plan usually includes buildings with wooden, metallic or masonry structures, machinery of mostly metallic components, pipework of various types, water tanks, animal food storage areas and sewage waste. Depending on the disease agent involved, different decontamination procedures and disinfectants are likely to be used for different sites on the property (Kostenbauder 1991).

In some cases where the disease agent does not spread directly from animal to animal (e.g. bluetongue) a comprehensive decontamination of a property is not warranted. In contrast, some viruses such as swine vesicular disease and foot-and-mouth disease, are relatively stable on inanimate objects and can be spread to remote animals on contaminated people, clothes, equipment, etc. Viruses that can be spread by such contact will require the most comprehensive decontamination programs.

Preliminary cleaning work is invariably needed before any chemical disinfectants are used. The natural processes of time, dehydration, warm temperature and sunlight will greatly assist the decontamination operation and should be considered in planning. A hot, dry, sunny day will cause rapid natural inactivation of an agent like Newcastle disease virus whereas cold, damp, overcast conditions will assist its persistence.

Simple cleaning of surfaces by brushing with a detergent solution is effective in removing contaminating viruses and is fundamental for achieving effective chemical decontamination. Most disinfectants have reduced effectiveness in the presence of fat, grease and organic dirt. Every effort should be made to remove such coverings from all surfaces to be decontaminated. Hot water and steam are effective in cleaning many cracks and crevices where pathogens are likely to linger. The insides of pipework can often only be cleaned effectively by steam. If applied long

enough for surfaces to approach 100^{o}C, the interior pipework ˙will be effectively decontaminated.

Choice of disinfectant depends on the method of application and how an adequate wet contact time is to be maintained.

A knowledge of the properties of the contaminating virus is crucial in planning a decontamination strategy. Choosing the most appropriate disinfectant is dependent on the nature of the virus particles. Useful clues for predicting susceptibility are the presence or absence of lipid in the virus particles and the virus size (Klein and DeForest 1981). In this predictive system, viruses fall into three groups:

- *Category A* viruses are of intermediate to large size and contain lipid which makes them very susceptible to detergents, soaps and all of the disinfectants listed in Section 3.2, below. Such viruses are susceptible to dehydration and often do not persist long unless in cool, moist environments.
- *Category B* viruses (eg picornaviruses and parvoviruses) have no lipid, are smaller and more hydrophilic. Such viruses are relatively resistant to lipophilic disinfectants such as detergents. Although they are sensitive to all the other disinfectants listed in Section 3.2, below, they are less susceptible than viruses in Category A. Classical bactericides such as quaternary ammonium compounds and phenolics are not effective against these viruses.
- *Category C* viruses (eg adenoviruses and reoviruses) are intermediate in size and lack lipid. These viruses fall between Categories A and B in sensitivity to the best anti-viral disinfectants such as hypochlorites, alkalis, oxidising agents, eg Virkon® and aldehydes.

Table 1 in Section 2 groups viruses of veterinary significance in their families and also in terms of their susceptibilities to common disinfectants.

3.1.3 Precautions when using disinfectants

Chemicals usually kill microorganisms by toxic reactions, and effective disinfectants are often toxic for animal (and human) tissues as well. Virtually all disinfectants have to be used with care to avoid occupational injuries or health problems. Table 5 Section 4 provides some basic information about precautions and contraindications when using the recommended disinfectants.

3.2 Selection of disinfectants

This manual concentrates on a relatively narrow range of disinfectants that are effective against broad groups of viruses. Consequently, disinfectants are recommended that are generally available in large quantity. Remember that in any large-scale decontamination of a farm or other infected premises, the cost of disinfectants will be relatively minor. Because labour and other operational costs will be high, it would be a false economy to use disinfectants at less than recommended concentrations. In any case, when disinfectants are watered down they invariably lose their effectiveness.

Flame guns may be useful supplements for drying decontaminated surfaces, but they are dangerous and the risk of fire and injury must always be considered. Flame guns are not recommended as a primary means of decontamination.
In general, chemical names of disinfecting substances are used because they are easily understood by all personnel with basic technical knowledge. This document generally avoids the use of brand or trade names because such products are subject to change or restriction in their distribution. However, Appendix 2 shows the names of trade products and the distributors from which supplies can be obtained.
To simplify determinations, disinfectants are grouped into five chemical categories.
(1) soaps and detergents
(2) oxidising agents
(3) alkalis
(4) acids
(5) aldehydes

Each of these classes of disinfectants is discussed briefly below and also shown in Table 4.

Commonly-used general disinfectants such as phenolics and quaternary ammonium compounds are very effective antibacterials, but have limited effectiveness against Category B and C viruses, and so are not included in Table 4.

Products effective for decontamination of viruses on the hands and the skin are limited. Virkon® is reported to have low toxicity and to be effective against members of all 17 virus families but it has not been approved for use on skin. Alternatively, citric acid or sodium carbonate may be added to washing water to induce antiviral conditions by lowering or raising the pH as appropriate for the agent to be inactivated.

3.2.1 Soaps and detergents

Soaps and detergents are essential components of cleaning procedures prior to many of the decontamination procedures described below. In most cases, the primary aim is the removal of organic material, dirt or grease from surfaces to be decontaminated. Most industrial and domestic brands of soaps and detergents are satisfactory. Hot water, brushing and scrubbing enhance the cleaning action. Similarly, steam improves the cleaning and decontamination process by raising the temperature and penetrating crevices. However, steam by itself can only be used as a decontaminant if the temperature of the surface can be raised to $100^{O}C$ and held there long enough for the inactivation of the agent of concern. Because of uncertainties regarding temperatures and times of contact, steam is only recommended as an adjunct to decontamination in this document.
In addition, the surfactant action of soaps and detergents is an effective decontaminant for all Category A viruses because of their outer lipid envelope. Thus, for decontamination procedures involving exotic viruses in Category A, soaps and detergents are effective disinfectants in their own right.

Many commonly-used disinfectants in hospitals, surgeries, dairies and food processing areas involve soapy combinations of phenolics or quaternary ammonium compounds. These agents are specifically antibacterials and are also effective against Category A viruses, but have limited activity against Category C viruses and in many cases, no activity against Category B viruses. Thus, although they may be useful for preparatory cleaning purposes during an exotic virus disease outbreak, they are not recommended in this manual as more effective cleaning agents and viral decontaminants are available.

Iodophors are combinations of solubilising agents and a carrier that releases free iodine. It is difficult to define active concentrations with certainty in all circumstances and so iodophors are not recommended in this manual for the inactivation of viruses.

3.2.2 Oxidising agents

These are the disinfectants recommended for most applications. *Chlorine* is released from hypochlorite solutions (either sodium or calcium) and is a powerful oxidising agent effective in killing all virus groups (Dychdala 1991). Scott (1980) found in the conditions of test that 0.175% sodium hypochlorite was the most effective and practical broad-spectrum disinfectant of 22 products tested against a range of different viruses. However, the effectiveness of hypochlorite is highest in the pH range 6–9 and decreases markedly in the presence of organic material. Hypochlorite powders are readily available as swimming pool disinfectants or household bleaches, and can be diluted for use on site. Hypochlorite solutions are not chemically stable and decompose rapidly as temperatures rise above 15^{O}C.

Virkon® is a modern disinfectant with outstanding virucidal properties. Virkon® is reported to have low toxicity and to be effective against members of all 17 virus families but it has not been approved for use on skin. Its activity is based on a buffered synergised acid peroxygen system containing a high percentage of surfactant. It is relatively safe to use and comes in a powdered form ideal for dilution at the site of an exotic disease outbreak. It can be sprinkled in powdered form over wet or boggy areas, *but the concentration of disinfectant achieved by that kind of application cannot be accurately controlled*.

3.2.3 Alkalis

Alkalis have long been used as effective disinfectants against a wide range of pathogens. Both *sodium hydroxide* (caustic soda) and *sodium carbonate* (washing soda) are widely available in large quantities at low cost and both have a natural saponifying action on fats and other types of organic matter which assists the cleaning process. Because they are virucidal under heavy burdens of organic material, they are ideal agents for decontaminating animal housing, yards, drains, effluent waste pits and sewage collection areas.

3.2.4 Acids

Acids are generally highly virucidal and with the correct choice of acid, or acid mixture, can be used under a wide variety of conditions ranging from liquid effluent to personal decontamination. *Hydrochloric acid* is a strong acid, widely available from hardware stores and less toxic than other strong acids. *Citric acid* is a milder acid available in solid form that is active against acid sensitive viruses and can be used safely for personnel and clothing decontamination. It is particularly useful when added to detergents for the inactivation of foot-and-mouth disease virus.

3.2.5 Aldehydes

Glutaraldehyde
A very effective disinfectant (Scott and Gorman 1991) active against all virus families (and other microorganisms) in concentrations of 1 to 2%. It remains effective in moderate concentrations of organic material, is chemically stable and only mildly corrosive for metals. However, for large-scale decontamination the cost is likely to be high.

Formalin
A 40% aqueous solution of formaldehyde gas and is a useful disinfectant. Formalin diluted with 12 volumes of water produces 8% formalin that is an active disinfectant against most virus families (but not against BSE).

Gaseous formaldehyde
Gaseous formaldehyde can be used to decontaminate air spaces, equipment that must be kept dry (such as electronic devices), and the insides of motor vehicle cabins. However, the conditions must be carefully controlled in terms of gas concentration, temperature, humidity, time of contact and even distribution of the gas. Under emergency conditions on a contaminated property, it is unlikely that all parameters can be controlled adequately. In addition, the space to be decontaminated must be completely sealed to prevent gas escape as the most effective 'dwell' time for the inactivation is an overnight period (Quinn 1991). Other problems with the use of formaldehyde gas for general purposes include the toxicity of gas; the dangerous nature of its generation in non-laboratory conditions (potassium permanganate reacts violently with formalin); the environmental protection guidelines that prevent the release of formaldehyde gas to the atmosphere; and the difficulty of completely purging residual formaldehyde gas from confined spaces.

In general, unless no alternatives are available, the use of formaldehyde gas on rural properties is not recommended. Unfortunately, no satisfactory alternative to formaldehyde for gaseous decontamination is available. Use of ethylene oxide or hydrogen peroxide for gaseous decontaminations must be restricted to carefully controlled laboratory environments.

For decontamination of vehicle cabins and electronic equipment on a farm, a clear-cut answer is not possible. A methodical and systematic approach based on first principles may have to be substituted. Cleaned vehicles and other machinery left in quarantine for a week in bright sunshine are likely to decontaminate naturally with

respect to most pathogens. Because the parameters for effective formaldehyde decontamination are so difficult to establish on a farm premises, formaldehyde gas is unlikely to produce an absolute result or to be significantly more effective than thorough cleaning. Where gaseous decontamination of equipment or machinery is considered to be unavoidable, specialist advice should be sought and the contaminated equipment kept in quarantine until that time. Further information on the practicalities of using formaldehyde gas are given in Appendix 3.

Table 4 shows which disinfectant should be used for inactivating each category of virus and what dilutions/concentration should be used.

Table 4 Recommended disinfectants and concentrations for inactivation of viruses

Disinfectant group	**Form[1]**	**Strength[2]**		**Contact time[4]**	**Applications and virus category**
		Usual dilution	**Final[3]**		
Soaps and detergents:	solids or liquids	as appro-priate		10 min	Thorough cleaning is an integral part of effective decontamination. Use for Category A viruses.
Oxidising agents:					
Sodium hypochlorite NaOCl	conc. liquid (10-12% available chlorine)	1:5	2–3% available chlorine (20,000 - 30,000 ppm)	10–30 min	Use for virus Categories A, B and C. Effective for most applications, except when in the presence of organic material. Less stable in warm, sunny conditions above 15°C.
Calcium hypochlorite $Ca(OCl)_2$	solid	30 g/litre		10–30 min	
Virkon®	powder	20 g/litre	2–3% available chlorine (20,000 - 30,000 ppm)	10 min	Excellent disinfectant active against all virus families.
Alkalis:					
Sodium hydroxide	pellets	20 g/litre	2%(w/v)	10 min	Very effective against virus Categories A, B & C. Do not use in the presence of aluminium and derived alloys.
Sodium carbonate – anhydrous (Na_2CO_3)	powder	40 g/litre	4%(w/v)	10 min	Recommended for use in the presence of high concentrations of organic material.
– washing soda ($Na_2CO_3.10H_20$)	crystals	100 g/litre	10%(w/v)	30 min	

contd.....

Disinfectant group	Form[1]	Strength[2] Usual dilution	Final[3]	Contact time[4]	Applications and virus category
Acids:					
Hydrochloric acid	concen-trated acid (10 Molar)	1:50	2%(v/v)	10 min	Used only when better disinfectants not available. Corrosive for many metals and concrete.
Citric acid	powder	2 g/litre	0.2% (w/v)	30 min	Safe for clothes & body decontamination. Especially useful for FMD virus decontamination.
Aldehydes:					
Glutaraldehye	concen-trated solution	as appro-priate	2%(w/v)	10–30 min	Excellent disinfectant effective against virus categories A, B & C.
Formalin	40% formal-dehyde	1:12	8%(v/v)	10–30 min	Disinfectant releases irritating, toxic gas.
Formaldehyde gas	Special generation required			15–24 hours	Toxic gas, recommended only if other methods of decontamination cannot be used.

Notes:

1) Commonly used general disinfectants such as phenolics and quaternary ammonium compounds are very effective antibacterials, but have limited effectiveness against Category B and C viruses, and are not included in Table 4.

2) Products effective for decontamination of viruses on the hands and the skin are limited. Virkon® is reported to have low toxicity and to be effective against members of all 17 virus families but it has not been approved for use on skin. Alternatively, citric acid or sodium carbonate may be added to washing water to induce antiviral conditions by lowering or raising the pH as appropriate for the agent to be inactivated.

w/v = weight/volume (ie 2g/100mL)

1 usual form supplied
2 recommended working strength
3 final concentration
4 required contact time for inactivation of disease agents

Estimation of quantities required
The amount of decontaminating agent necessary for particular jobs varies considerably. For a polished, non-porous floor, 100 mL of disinfectant/chemical applied per square metre is probably sufficient. However, for porous surfaces such as concrete or wood, the volume may need to be doubled or tripled.
Generalisations are not useful as application of liquids to ceilings or vertical walls cannot be well controlled.

It is most important to remember that, after having cleaned the surface, the time of contact is of critical importance. For most applications, disinfectant must flood the surface and keep it thoroughly wet for at least 10 minutes.

3.3 Safety precautions

3.3.1 General safety precautions

First aid boxes must be available on every infected premises (IP)/dangerous contact premises (DCP) or where hazardous chemicals are being used. It is essential to brief workers and the property owner on safety aspects before commencing operations, including the potentially harmful effects of chemicals on animals, humans and the environment.

The usage of any chemical or equipment should conform to the manufacturer's instructions and safety standards. All officers and workers must carry out their duties in accordance with current health and safety legislation. All accidents which require medical attention, however small, must be logged with details reported back to the Local Disease Control Centre (LDCC).

3.3.2 Acids and alkalis

When diluting concentrated chemicals, the concentrate should ALWAYS be added to water, NEVER water to concentrate. Do not mix acid and alkali disinfectants. Apart from the resulting chemical reaction, the effectiveness of both chemicals is nullified. Contact with concentrates on exposed skin will cause severe burning. All workers engaged in mixing or applying disinfectants must wear boots, overalls, goggles and head covering for protection. Use a full face guard when applying the diluted chemical. Avoid the danger of inhalation by NOT applying a MIST spray.

If contact occurs:
- wash with copious amounts of water immediately;
- apply vinegar to caustic alkali burns OR apply bicarbonate of soda to acid burns; and
- refer for hospital treatment if necessary.

Eye damage should be irrigated copiously with eye wash solution and referred to hospital. Store concentrate containers in one place on the property away from the main area of work in order to remove the danger of containers being ruptured inadvertently. Check the containers each day for spillage of concentrate.

3.3.3 Aldehydes – formalin, glutaraldehyde and formaldehyde gas

These disinfectants should be used only when no alternatives exist, and then only by experienced personnel with appropriate safety equipment. Gaseous formaldehyde is applicable to:

(i) all enclosed spaces which can be made airtight (for example, grainbins, electrical fuse boxes covered in plastic);
(ii) as (i) which contains electronic or electrical machinery;
(iii) delicate equipment which can be enclosed in a plastic ‘tent’ and fumigated;
(iv) for some heavy machinery vehicle cabins; and
(v) poultry incubator rooms and egg rooms.

The safety of the operator is of greatest importance and the method of use of formaldehyde is based on the safety aspects (see Section 4). These substances **can kill operators and even small amounts** can have a detrimental effect on all living tissue. If the chemical enters the eye, any wound or abrasion it is extremely painful. The fumes damage all mucous membranes. Always wear a **protective face guard** when mixing.

This method should only be used when it is impossible to use other procedures. Warning notices should be fixed to the entrance of an area being fumigated. There should be two people involved in the operation — both equipped with **full face respirators** effective against formaldehyde gas.

3.3.4 Special considerations when using disinfectants

Table 5

DISINFECTANT	HEALTH ASPECTS	ENVIRONMENTAL PROBLEMS AND CONTRA-INDICATIONS
Hypochlorites	Toxic for eyes and skin	Strong bleach. Inhibited by high concentrations of organic matter. Corrosive for many metals.
Virkon®	Reasonable care necessary	
Sodium hydroxide	Caustic for eyes and skin	Avoid contact with strong acids. Cannot be used on aluminium or like alloys.
Sodium carbonate	Mildly caustic for eyes and skin	Avoid use with aluminium and like alloys.
Hydrochloric acid	Toxic for eyes, skin and respiratory passages	Corrosive for many metals and concrete. Avoid contact with strong alkalis.
Glutaraldehyde	Avoid eye and skin contact	
Formalin solution	Releases toxic gas; irritating for mucous membranes	
Formaldehyde gas	Very toxic for mucous membranes in concentrations down to 2 ppm	Cannot be used in presence of water, hypochlorites or chlorides. Cannot be released to atmosphere without neutralisation. Corrosive for some metals.

ppm = parts per million

4 BATTLEFIELD STRATEGY – disinfection procedures

4.1 Personal decontamination

The aim of personal decontamination is to safely remove any contamination of the body or clothing. The process minimises the risk of cross-contamination so that people can confidently remove themselves from a contaminated environment with nil/minimal dissemination of the disease organism. These procedures MUST be rigorously applied.

Heavy personal contamination may occur while working on infected premises or dangerous contact premises and when active disease is found by diagnostic and surveillance teams.

The heaviest contamination will occur:

- when living infected animals are physically inspected;
- when slaughtered animals are physically inspected and diagnostic samples taken;
- at the slaughter site on an Infected Property (IP) or Dangerous Contact Property (DCP);
- at the site of carcasse disposal; and
- when removing the manure, bedding and detritus from buildings which housed infected stock.

4.1.1 Personal decontamination site

A site designated for personal decontamination (PDS) should be arranged near the exit point from an IP or DCP. This site may be moved further into the IP as necessary during decontamination. The site supervisor will be responsible for selecting the area.

Critical inspection and questioning of the owner/manager of the property will determine the extent of property contamination with regard to animal and effluent contact. The PDS should be placed on the limit of this contamination or in an area that can be easily and safely disinfected. It should allow for future expansion and may be in use over a considerable period of time. Once determined, the site area should be sprayed with a disinfectant applicable to the disease. It must be possible to leave the IP directly from this PDS without becoming re-contaminated. Ideally it should be on an impervious surface and include a building with water and drainage supply. The building should not have been previously used by animals or have been grossly contaminated. If there is no hard standing available a plastic ground cover 10 metres by 10 metres can be used. Hessian sacking and star pickets round the area can be used to maintain privacy for changing. Each person should have a clean change of clothes kept in plastic bags or in the caravan at the outermost point of the area with a store of clean overalls in case of mishaps.

Other more effective equipment for personal decontamination are State/Territory emergency service shower vans and, in cold climates, two room vinyl marquees can be used for shelter, washing and privacy.

Consideration must be given to any sloping ground. Run off water from the contaminated area *must not* flow to the clean area. If no adequate drainage is available, a pit must be dug as soon as heavy machinery arrives, to ensure no effluent escapes beyond the decontamination site.

4.1.2 Personal decontamination – procedure

The following procedures will apply to ALL personnel before leaving an infected property or dangerous contact property or any quarantined area which is grossly contaminated with the disease organism.

On arrival at the decontamination site a disinfectant solution safe for skin contact should be ready in buckets which is used throughout the operation. Antiviral disinfectants effective against all virus families and *approved for use on human skin* are *not* available. Therefore, warm soapy water is recommended for washing face, hair, skin, etc.

Alternatively, the pH of the washing solution can be raised (by adding sodium carbonate) or lowered (by adding citric acid) to enhance antiviral action, the latter being recommended for the decontamination of foot-and-mouth disease virus (Table 4). If other skin decontaminants are used, care must be taken to ensure they are effective against the virus of concern as many brand products containing quaternary ammonium compounds or phenolics are *not active* against Category B viruses.
Heavy gauge plastic garbage bags are used for disposable items which can be buried or burnt on the site or for items to be removed from the site for further disinfection and cleaning.

Industrial hard hats must be scrubbed and set aside. If a neck cloth is worn, it must be removed and soaked in disinfectant (e.g. 1% Virkon® for 10 minutes), wrung out and placed in a plastic bag. Hair should be

washed/sponged down with a shampoo. Disposable gloves must be decontaminated before discarding; reusable gloves are decontaminated before reusing. Hands must be washed in disinfectant and scrubbed.

Plastic overalls

Using a sponge or low pressure pump, wash the overalls from top to toe to remove gross material paying particular attention to the back, under the collar, zip and fastenings and the inside of pockets. The jacket is removed and then placed in disinfectant. The trousers are treated similarly paying attention to crutch, pockets and the inside of the bottom of the trouser legs. The trousers are then removed, inspected and placed in disinfectant. Wellington boots are scrubbed down, particular attention being paid to the sole.

If the person is returning to the site the next day, hat, gloves and plastic overalls are removed from the disinfectant and can remain on site. If the person is not returning, the equipment is placed in plastic bags, and the outside of the bag disinfected. The person then walks across the area, treats the soles of the boots again, changes into street shoes and leave. If underclothing has been soiled especially above boot level, it must be removed and placed in a plastic bag, the skin washed and a clean pair of overalls used for leaving the site.

Cotton overalls

Overalls are simply removed, soaked in disinfectant, squeezed out and placed in a plastic bag for removal. Underclothes are similarly treated. Wellington boots are similarly treated. The body is washed down. The person then walks across the area, washes feet in a footbath, changes into clean overalls and street shoes and leave directly without re-exposure to contaminated areas.

The plastic bags containing used overalls and other articles are sealed and given a second wash down in disinfectant and then placed at the outer limit of the area for collection by courier. These are then taken for cleaning.

On returning to home or lodgings, the person should have a shower.
If people are leaving an IP or DCP for other duties they must not have contact with susceptible stock for a period of time as directed by the Local Disease Control Centre (LDCC).

4.1.3 Personal decontamination in difficult circumstances

Visitors on properties where disease is suspected

It is possible that when a disease is suspected on a property, there will be visitors or private veterinarians present. These people should be requested to remain on the property until the government veterinary officer arrives, or if this is not practical, they should be asked to undergo personal disinfection particularly if they have had contact with livestock or contaminated areas.

Use of the following substances as personal disinfectants can be recommended where no other approved disinfectant is available:

- domestic washing soda (10 parts in 100 parts hot water);
- soap (or household detergent) and hot (60°C) water for scrubbing; and
- household concentrated *chlorine* bleach (1 part in 3 parts water to give 2–3% available chlorine). *This is not to be used on hands, face or skin.*

Any area of the body and parts of the vehicle contaminated with animal matter should be washed down using one of the above solutions. The person must not contact any animal and must be questioned in detail regarding movement from the time of contact with suspect disease to the time the officer requests the information. The person should be requested to dry clean/wash clothes on arriving home and to have a hot bath or shower. There must be no visits made to properties with livestock until the situation has been resolved. If the suspect property proves positive, the person will be directed to present the vehicle for appropriate decontamination.

Accident cases from an IP or DCP

The level of initial decontamination of a person injured while on an IP will vary with the extent of the injuries. Obviously, a human life must not be prejudiced and every care taken to minimise discomfort or pain.

If a risk of contamination is deemed to exist because of incomplete personnel/vehicle procedures, in an emergency situation, the LDCC must be informed and an officer dispatched to the ambulance destination. Hospital authorities should be informed of the risk and appropriate personal disinfection of the patient carried out as circumstances permit. Personal protective clothing worn by the casualty must be secured in plastic bags and any area thought to be contaminated, washed with approved disinfectant. The ambulance wheels, underside and interior should be washed with approved disinfectant. Personal clothing and boots of the ambulance attendants should be removed for dry cleaning and disinfection if they had to enter the IP or DCP.

4.2 Property decontamination

The IP site supervisor must ensure effective property decontamination, including decontamination of people, equipment and vehicles.

Efficient and effective property decontamination will only result from:

- a presumptive identification of the suspected exotic disease;
- assessment and recording of the contaminated areas, animals and articles;
- the selection of the most suitable decontamination techniques for each item and area;
- the acquisition of necessary equipment and materials and recruitment of personnel to undertake the tasks; and
- the adoption of an appropriate strategy.

The following regime is recommended.

1) Inspect the IP or DCP and prepare a map of the property.

2) Start a log book to record all events and recordings.

3) Indicate areas NOT requiring special decontamination action.

4) Indicate areas or sites requiring specific decontamination action (consult with the officers-in-charge of slaughter, disposal, and epidemiology).

5) List the proceedings to be undertaken in chronological order within each area.

6) Estimate a time-frame for the decontamination program.

7) Seek approval from the LDCC operations manager for the proposed program.

8) Implement the agreed decontamination plan, maintaining liaison with the IP operations manager at the LDCC and submitting a daily progress report.

The composition of a typical property decontamination program is listed as follows:

- presumptive identification of the disease agent
- property assessment
- preliminary disinfection
- first clean-up
- first disinfection.
- first inspection
- second disinfection
- final inspection

Continuous close liaison with the owner/manager is essential to achieve an effective program.

4.2.1 Property assessment

The initial property assessment must be detailed thoroughly. This assessment will be used throughout the decontamination process. Mark relevant details on the property map. Identify overhead high tension electricity power poles and lines, underground cables, telephone lines, electricity fuse box, power points and meter. Where necessary identify underground water pipes. Locate and mark all DRAINS and their run-off. Any drains which run free must be blocked with hessian or plastic bags and only allowed to run when the effluent has been thoroughly mixed with disinfectant. If effluent is running freely into creeks etc arrange to dig a pit or dam across the drainage line. Where possible, check water authority drainage maps to determine subsequent flow of effluent**.** If the drainage is to a septic tank, examine the tank, estimate the spare capacity and note this down. If the tank is full, block the drains.

Examine the DECONTAMINATION SITE. If a temporary one has been set up, it may require moving because of the potential increase in traffic or effluent overflow. The site must be delineated and disinfected. Detail an unloading area, outside the decontamination area where materials and equipment can be unloaded without having to decontaminate a vehicle. Detail an area where the workforce will eat or have tea breaks. There should be provision for heating water and preferably cover or shade, but NOT at the decontamination site.

Estimate the degree of contamination within the DWELLING HOUSE and its immediate surrounds. Detail disposal and/or cleaning to be done within the house to remove all source of contamination. Special attention should be paid to verandahs and office. If it is possible, and without prejudicing disease control, detail a decontamination procedure to allow the household to safely move off and on to the premises. This will depend on the siting of the house and the possibility of disinfecting to a point outside the designated contaminated area.

Arrange for 'INFECTED PREMISES' notices to be posted at the entrance to the property.

On intensive piggeries and poultry farms, turn off all extractor fans. This is particularly important for disease agents that are easily dispersed as aerosols such as foot-and-mouth disease virus and Newcastle disease virus.

Assess the amount of animal effluent to be removed for disposal. Assess the amount of food that will be needed for the animals. It may be necessary on welfare grounds to arrange delivery of more food before disposal of stock is completed. The delivery vehicle must be decontaminated before leaving.
Detail structures and articles that cannot effectively be decontaminated, such as wooden buildings, floors, doors and linings, roof insulation and cattle yards (timber). Assess the degree of contamination of non-animal areas — machinery sheds, workshops, grain and food stores. Assess the likely contamination of animal feed; open sacks of food, loose grain stores, hay and straw stacks especially if under-run with animal effluent. Detail specialist electrical and electronic equipment requiring decontamination with advice from electrical contractors.
On extensive properties, designate an area at the airstrip as a small decontamination site for the pilot and any essential visitors. This can be a scaled down version of the decontamination site.

4.2.2 Preliminary disinfection

The aim of preliminary disinfection is to rapidly reduce the amount and distribution of the infective agent on the IP or DCP up to the time of the completion of slaughter and disposal when thorough disinfection can be undertaken.
Preliminary disinfection should be commenced as soon as possible after the presence of disease is confirmed on the property. Any area known to be contaminated is sprayed with disinfectant solution, thus reducing the chances of inadvertent spread of the infective agent. When the disease agent has the capability of airborne dissemination the importance of pre-slaughter spraying cannot be over-emphasised. The process should continue area by area until the first clean-up operation starts. Particular attention should be paid to the roadway for entrance/exit of property for vehicle access, overflows of animal effluent onto roadways or tracks and dwelling house surrounds.

Slaughter site

This area should be disinfected at every long break—probably 5 times a day. This should include buildings and pens housing animals, and, as the animals are successively removed for slaughter, the area they occupied.

Disposal site

This area must be decontaminated thoroughly but only when disposal has been completed as wetting some soils makes traction difficult and would cause problems with vehicles on the site.

Allow all heavy machinery to return to a central point in the IP. Heavy machinery not required on the property after completion of carcasse disposal must be carefully disinfected. Spray along the track to the disposal site and follow with a heavy spray where carcasses have been slashed open. Where carcasses are burnt, the spraying will have to wait until the fire has died down. When all the animals have been destroyed, any wood used for temporary slaughter pens must be buried or burned. All metal gates and panels at the slaughter site are to be scrubbed down with disinfectant and stacked for complete disinfection. The slaughter site can then be thoroughly decontaminated.

Rodent control

While the preliminary disinfection is being carried out, the IP site supervisor will arrange with the LDCC for the laying of baits for rodent control, if this is thought necessary to limit the spread of disease. This must be carried out before there is movement and/or disinfection of food stores.

4.2.3 Clean-up process

The aim of the clean-up process is to remove all manure, dirt and debris and contaminated articles that cannot be disinfected. The surfaces of all buildings, pens, fittings and equipment must be exposed ready for the first disinfection. This is the most important phase in the decontamination procedure because the presence of organic material reduces the effectiveness of disinfectant.

Encrusted dung, dirt and grease shield the underlying permanent surfaces from the effect of the disinfectant. Remove large accumulations of faeces, litter and bedding. Avoid the use of water or disinfectants at this stage. This material will have been lightly disinfected at the preliminary disinfection. This minimises the volume and weight of runout to be handled. The easiest method of disposal of solid and semi-solid faecal material is burial. When animal houses have been cleared of dung, start cleaning the building from the roof working downwards.

All old insulation material (polystyrene, fibreglass and press boards) are removed for burial or burning unless they have sound impervious surfaces which can be effectively decontaminated. All unsound, rotten and underrun wooden fittings and flooring and other structures which cannot be effectively disinfected should be removed for burning or burial. Remember all material destroyed must first be valued. All fixtures and fittings should be dismantled and stacked for cleaning and disinfection. All delicate electronic equipment must be protected for later specialist treatment.

Earthen floors in buildings may need to be broken up and soaked in disinfectant. Concretions and encrustations of material on permanent surfaces are removed. This is most easily achieved by low pressure spraying with water, or water and detergent, using steam cleaners or scraping with hand tools. Particular attention should be paid to corners and wall/floor junctions. The surfaces are then washed down using a high pressure system and plain water. All permanent surfaces must be free of visible contamination. All feedstuff

considered contaminated must be removed and buried after valuation. Feeding and water troughs are emptied and cleaned out.

4.2.4 First full disinfection

The aim of the first disinfection is to inactivate the disease agent using physical and chemical agents. The necessity for any disinfection depends on the disease agent involved**.** This process must be carried out in a systematic fashion to ensure that areas which have been disinfected are *not* re-contaminated by people or machinery. A recommended order of cleaning is: roof – wall – floor, and this should be adopted in each building**.** When the disinfection of each building or area is completed it should be cordoned off with marking tape. Once an area is dry it will not be obvious where the disinfected area starts and finishes.

The disposal site is periodically inspected. Burial pits will emit large quantities of noxious gas and fluid. Once this emission has stopped, the ground around the site is broken up and liberally soaked with disinfectant. Treat cremation sites the same. Care must be taken to disinfect personnel, machinery and vehicles close to the site and not allow recontamination of previously disinfected areas near buildings.

4.2.5 First inspection

Depending on the disease agent involved, this may be the only inspection**.** The aim of the first inspection is to ensure that all tasks which were detailed on the property assessment have been performed. The property is inspected by the IP site supervisor from the LDCC.

Important aspects to be checked are that:

- all contaminated woodwork not able to be cleansed and disinfected has been completely disposed of;
- all fixtures and fittings have been dismantled where appropriate so that no organic material is left behind them;
- there are no observable encrustations on any exposed surface;
- all contaminated feedstuff has been destroyed, and remaining material made safe;
- all grossly contaminated sites (slaughter and disposal) have been effectively cleaned and disinfected;
- all fluid that has been disinfected has been released into drains or septic tank;
- the conditions of quarantine, especially at exit/entry points, and warning notices are being maintained.

4.2.6 Preparation for second disinfection

There can be a potential residue of contamination particularly under old cracked concrete and under rundown buildings.

Areas of underrun or loose concrete should be examined carefully and a cost assessment made whether they are to be re-rendered, repaired or the area destroyed. Earthen pathways and walls of animal houses which are constructed of porous brickwork or 'breeze block' should be similarly inspected and assessed.
If repair/re-rendering work is done, a written agreement with the owner on the work to be done must be obtained before any work is commenced.

4.2.7 Second full disinfection

The work detailed must be finished or in such an advanced stage of progress that it will not hinder the second disinfection process.

The second disinfection is a repeat of the first and can be started approximately 14 days after the first disinfection, depending on the disease agent involved and provided no rendering work needs to be done.

4.2.8 Final inspection

This inspection is carried out in the same way as the first inspection. The premises must be meticulously inspected preferably by an experienced officer not previously involved in an earlier inspection**.** If there are any doubts, then work must be repeated. If there are no questionable areas, the workforce is removed from the premises. All equipment and personnel are finally disinfected at the decontamination site before removal. If the final inspection is satisfactory, reconstruction work can be carried out and the premises made re-habitable for stock. The premises are left empty for a prescribed time before restocking with sentinel animals, depending on the specific disease strategy.

4.2.9 Restocking sentinel animals

Depending on the local disease situation, sentinel animals may be allowed back into the premises at a time determined in accordance with the relevant disease strategy. They must come from a disease-free area of the

country. The sentinel animals must be inspected by a government veterinary officer before loading. The sentinel animals will be housed in those areas that had the highest degree of contamination.
The vehicle and driver should be disinfected when leaving the receiving property. This is because the driver may have further contact with other animals and if there has been any breakdown in decontamination, the consequences would be serious**.**
The animals will require regular clinical inspection. The officer doing the inspection must disinfect off the premises at each visit. If there is no sign of disease at the end of the sentinel period, the premises are declared free of disease and quarantine lifted, depending upon any local disease control measures in force at the time.

4.3 Vehicle and machinery decontamination

Contaminated cars, livestock, animal feed or product haulage vehicles with their drivers carry a disease dissemination risk. The first priority is to ensure no vehicles leave the IP without thorough decontamination. A second priority in any disease outbreak is to trace urgently vehicles that have been in contact with the disease agents — taking them off the road and decontaminating them thoroughly. Inquiries should be made about the origin and occupation of the travellers and any contact they may have had with livestock.

Most vehicles should remain off IPs or DCPs. If the numbers of vehicles warrant it, a local area with a hard standing, drainage and a good water supply should be designated as a local vehicle disinfection station. A carwash facility is ideal for decontamination of surveillance vehicles if one is conveniently located. A carwash can do the job quickly and more effectively than a team of people and has the advantage of being able to wash under vehicles very easily. Although this cleaning may be unnecessary from an epidemiological point of view, it is very effective public relations to have clean vehicles visiting suspect private properties.
Vehicles can be divided into four broad categories:

- those that do not need cleaning and disinfection;
- those that need the wheels cleaned only;
- those that need the outside cleaned only; and
- those that need both outside and inside cleaned.

4.3.1 Cars

Any rubber floor mats on the driver's side should be removed for scrubbing with disinfectant. The dash board, steering wheel, handbrake, gearstick and driver's seat should be wiped liberally with appropriate disinfectant. If the boot *is considered contaminated*, the contents must be removed and the interior of the boot wiped with disinfectant. The contents of the boot must be treated similarly before being replaced. The wheels, wheel arches and undercarriage of the car should be sprayed with disinfectant — NOT plain water. The vehicle wheel arches, wheels and bodywork should be sprayed with a non-paint corrosive disinfectant.
Plain water is not to be used with power hoses because the process will release contaminated aerosols of the pathogen. A mixture of disinfectant and water should always be used with power hoses. Cleaning heavily contaminated vehicles would only be done on the infected rural IP as most cleaning processes, including power hoses, spread the infectious agent.

Cleaning using disinfectant/soap and water with *brushing* to dislodge encrusted dirt and organic matter is preferable to washing with strong water streams. Caustic soda should not be used on paintwork.

4.3.2 Livestock vehicles

All solid debris should be removed from trailers and the like. The vehicle is then soaked in disinfectant using a detergent, and scrubbed down to bare metal or wood.
When the crate structure of the trailer has been decontaminated, the crate should be lifted free from the body, the undersides of the stock crates and where the crate was sited on the trailer, decontaminated. The vehicle must be closely inspected to identify if there is a double layer. If this is so, the top layer of metal tread plate or wood must be removed to reach areas where contaminated material could be trapped. Any metal flooring which appears solid must be weight tested to ensure welding is not cracked and that there is no rubbish under the flooring. Some trailers may carry extra equipment under the body — this must be treated. The outside dual wheels and spare wheels must be removed to ensure:

- adequate decontamination of wheel hubs; and
- to inspect the spare wheel hangers which can be of hollow construction and therefore could hold contaminated material.

The driver's cabin and, where fitted, the sleeping compartment must be thoroughly cleaned and decontaminated. Enquiries should be made of the driver as to what clothing and boots s/he was wearing when in contact with suspect stock. These articles must be identified, decontaminated and arrangements made for dry cleaning where applicable (see Section 4.1.2).

All animal faecal matter and bedding must be removed. All water, feedstuff and litter carried in the vehicles must be disinfected and burnt or buried. All fixtures and fittings must be dismantled to ensure that infected material has been removed. All surfaces must be cleaned down to metal and then disinfected. Any wooden

surfaces must be cleaned and disinfected where appropriate or valued before removal and destruction. The wheels, wheel arches, bodywork and undercarriage must be cleaned of detritus and disinfected. The drivers cabin and sleeping compartments also need to be cleaned and disinfected. It is common practice for specialised vehicles to be self-contained with water, food and litter supplies for the animals.

If the vehicle is known to have carried diseased or suspect stock, then every effort should be made to identify the area of disposal of these materials if they have been removed before departmental officers have identified the vehicle as being contaminated. Once identified, these materials must be disinfected and disposed of by burial or burning.

Other livestock-carrying vehicles can include horse boxes (single or multiple), vehicles carrying stud and show stock and racing pigeon carriers. For any vehicle known to have carried stock susceptible to the disease organism, the principles of vehicle and trailer decontamination are the same.

4.3.3 Milk tankers

These vehicles can become contaminated and disseminate the disease organism in the following ways:

- picking up infected milk from a dairy farm, while the disease is incubating;
- allowing a contaminated aerosol to be released from the milk store; and
- mechanical means (by vehicle and driver).

Disinfectants used within the tank must be those which do not leave a 'taint'. Every dairy factory will have a disinfection point for tankers/drivers and an approved disinfectant against the disease organism. The vehicles must be cleaned and disinfected at the end of each day.

When picking up milk in a control area, tankers must be disinfected off any potentially contaminated area, paying particular attention to wheels and hose inlets. The tanker exhaust vent must be fitted with hydrophobic membrane-type filter elements rated at 0.2 µm. The filter elements should be selected to permit air displacement flow rates during tanker emptying and filling without exceeding tanker vessel design pressures. Filter housings should be selected to permit cleaning and decontamination in place. Filter housing outlets should be protected against the ingress of rain, hose down water and insects.

Any spillage of milk must be disinfected. The drivers must disinfect themselves off each property. If the disease does not affect cattle, the decision to allow a milk tanker into a mixed animal enterprise will depend on:

- amount of spare capacity in the bulk tank;
- the level of decontamination achieved on the property; and
- the opinion of the IP site supervisor.

The vehicle and driver must be decontaminated before leaving.
If it is determined that the tanker is carrying infected milk, the volume of milk is determined, the milk mixed with the correct strength of disinfectant using a disc plunger, left standing for one hour and then discharged to a drain or pit. The interior of the tanker must be decontaminated along with all hoses and fittings. Principles of vehicle decontamination discussed previously must be observed.

4.3.4 Animal feed delivery vehicles

The visits of feed delivery vehicles to an IP or DCP will be identified from the epidemiology report. The path of the vehicle through the IP or DCP must be traced and the degree of contamination of vehicle and driver ascertained. When the vehicle has been determined to have visited another property, the path of the vehicle and driver and the area of possible contamination and contact with susceptible animals must be traced. When a suspect vehicle has been detained, decontamination will require removal of all encrusted material in wheel arches, wheels and the underside of the body, and depending on the degree of contamination of the driver, his or her clothing, boots and cabin.

An epidemiology report could identify bulk or bagged food material of animal origin, eg meat and bonemeal which has been carried by the vehicle, as being contaminated. Residual food material in the vehicle must be sprayed with disinfectant and removed for disposal. The inside of the bulk trailer must be decontaminated with approved disinfectant.

If it is necessary on animal welfare grounds or in a mixed animal enterprise to allow a food vehicle onto an IP or DCP the route within the IP or DCP should be specified to the driver so as to minimise contamination of the vehicle. The vehicle and driver must be thoroughly decontaminated before being allowed to move off.

Wherever practical, animal feed should be delivered to the outer limits of the property and then transferred to the animals without the vehicle or driver of the delivery vehicle becoming contaminated.

4.3.5 Vehicles at alternative disposal sites

Under extraordinary circumstances carcasses, offal and other contaminated material may have to be moved off the IP or DCP for disposal elsewhere, if, for example the land area on the IP or DCP is limited or the topography is unsuitable or environmental factors preclude the use of normal disposal methods.

The transport vehicle body container will have to be drip proof, preferably with a rear opening, capable of tipping, and capable of being sealed at the top. If such conditions cannot be met, there must be a crane at the disposal site for lifting carcasses out. The designated disposal site will be as close as possible to the IP or DCP and the access route determined as being of no danger to other susceptible stock. The disposal site will be designated as a quarantined area. The vehicle will be loaded using a suitable 'lift' crane/cargo net or front–end loader. Once the vehicle is loaded, the carcasses or contaminated material will be sprayed with disinfectant. The driver and vehicle body, wheels and undercarriage must be decontaminated thoroughly before departure. The cover of the container must be strapped down tightly and decontaminated.

The journey speed must be limited to 40 km/hour. This slow speed is recommended to minimise aerosol release.

At the disposal site, there must be sufficient equipment, water supply, drainage and materials to decontaminate the expected number of vehicles. The facilities should be arranged at a specific decontamination site. Each driver and vehicle must be decontaminated before leaving the disposal site.

On completion of the exercise:

- all vehicles and equipment will be decontaminated off the site;
- the area of disposal will be soaked in disinfectant;
- the area will be securely fenced;
- after 21 days, the burial site will be revisited and the mound and surrounds disinfected again under supervision of a departmental officer; and
- quarantine will remain in force for a period to be determined by the LDCC controller.

4.3.6 Aircraft decontamination

Aircraft construction prohibits the use of a strong alkaline disinfectant such as caustic soda because of severe corrosion problems with metals such as aluminium.. A mild alkaline disinfectant suitable for use on aircraft is sodium carbonate with 0.1% sodium silicate. Care is required with specialised equipment within the aircraft.

NB Helicopters should not be used in close proximity to the IP where aerosol disease spread is suspected, for example, with foot-and-mouth disease virus.

4.3.7 Other machinery and vehicles used on IP or DCP

Heavy machinery used on an IP or DCP will be grossly contaminated. This includes:

- mechanised diggers for burial pits;
- bulldozers for pushing carcasses;
- front-end loaders for carrying carcasses, faecal and other material;
- tractors/trailers for carrying carcases, faecal and other material;
- cranes for carcasse lifting; and
- chains hooks and cargo nets.

Such equipment must remain on the IP until needed elsewhere.
Once carcasse disposal has been completed, machinery must be decontaminated. When the vehicle has been decontaminated, it is moved to the decontamination site and the tracks disinfected again. The cab must not be re-contaminated when moved by the driver. All ancillary equipment will be treated similarly. The driver must be decontaminated. Where low loader vehicle transporters are required, they should NOT be allowed onto the IP. The vehicle leaving the IP should load outside the IP limits.

5 AREAS OF SPECIAL CONSIDERATION

5.1 Animal effluent

5.1.1 Slurry

The amount of spare space in the slurry tank will govern the course of action. Identify where the previous loads of slurry have been spread or disposed of, and the disease risk. If the slurry tank is almost full, an alternative pit can be dug (and if necessary lined with plastic sheeting) into which slurry can be pumped for treatment. Slurry pits may be underfloor tanks within buildings or tanks in the farmyard. Any covers should be removed.

Estimate the capacity of the tank. Use chemicals to modify the pH to <2.00 or >11.00 and test using universal indicators. Mix using a slurry tanker pump or agitator. Keep at the required pH for 7 days. Neutralise the mixture and spread on non–grazed agricultural land.

Safety

- Be aware that agitation of the material can release a mixture of carbon monoxide and dioxide, hydrogen sulphide, ammonia and methane.
- Explain safety aspects to workers. Only use as many people as necessary.
- **Never** have one person working in a tank on their own.
- Provide as much ventilation as possible if indoors.
- If necessary wear respirators, safety harness and lifeline. Slurry level should never be less than 30 cm from the top of the tank.
- Never trust the 'crust' on top of a tank to take weight.

Semi-solid slurry tanks

Often it is not feasible to liquefy this material. Most of the material will be non-infective. Add caustic soda 2% to the surface and allow to stand. Further additions of material to the tank must be treated before entry. Quarantine the tank for up to three months, depending on the disease agent involved.

5.1.2 Manure

If the volume is not great, spray with an acid disinfectant, as manure tends to acid pH and this can be enhanced by acid treatments**.** Note that hypochlorite has limited effectiveness in the presence of high organic loads.
Remove treated manure and bury in a pit.

5.2 Dairy equipment and milk storage tanks

There may be varying amounts of milk in bulk tanks on the IP or DCP. Depending on the disease the milk must be made safe with a disinfectant which is added to the milk and agitated. The milk is then held for 1 hour and then released into a pit — NOT into the slurry tank.

Milk from properties in a restricted or control area may be removed from the property provided the driver and vehicle are disinfected on leaving contaminated areas and the milk is subjected to appropriate treatment for the disease.

Milking machines

These machines need to be stripped to their components and then boiled or scrubbed with disinfectant. All instruments and gauges are removed from the milk lines and disinfected. The apertures are 'stopped' and all lines filled with non-taint disinfectant. This is left in contact for one hour. The joints of the pipeline are then loosened to allow seepage. The lines are then run through with plain water and then with chlorine dairy detergent.

5.3 Animal feed

There will be varying amounts of animal feed on the IP or DCP. Some may be unaffected, some safely decontaminated, and other feed may have to be destroyed. The destruction of large quantities of animal feed is expensive. Manual labour costs of treating the feed may outweigh the benefits of keeping it. Depending on the disease agent involved, keeping the feed or treating it may be judged as too great a risk to contemplate. However, most exotic viruses inactivate spontaneously with time and certain temperature and humidity

conditions, thus in some cases feed can be quarantined for a period determined by epidemiology, then used again with confidence.

5.3.1 Hay and straw stacks

The length of time the disease has been present on the property will be determined from the epidemiology report. If it is a new stack, it may have been contaminated throughout by the footwear of workers while stacking it.

Designate a new stack area and start disinfecting it. As the new stack progresses — spray with 2% caustic soda . Leave for 30 days and then restack, retreat and again leave for 30 days. The material can then be spread on arable land. Wherever possible bury the material.

Given the amount of time and labour required to treat and restack, it may be more economical to destroy the whole stack and compensate the owner. The contaminated bales can be used by the disposal team, if appropriate. If the disease is affecting only one species of animal in a mixed enterprise, the stack may be used for bedding/feed until the time of the second disinfection.

5.3.2 Grain stores

There may be many tonnes of grain on a mixed farm enterprise. The owner/manager must be carefully questioned as to the likely degree of contamination on the floor before the grain went down. Also seek epidemiological advice as to the length of time the disease agent has been present. If no underlying contamination exists, remove approximately 7 cm of the surface of the grain and spray the new surface with disinfectant. The removed grain and scrapings are buried or burnt. Grain may sprout after this treatment or go mouldy, and this must be taken into account in the long term.

With bins of grain incorporated into home mixed rations, the floor of the bin can be easily contaminated by farm workers auguring out the last grain before refilling the bin. If this is found to be the case, remove the grain and destroy it.

5.3.3 Silos

Silos can hold many tonnes of grain or prepared feed. If it can be determined that there is or has been no disease contamination, remove approximately 25 kg of the contents through the chute. Wipe the inside and outside of the chute with disinfectant. Enclose the chute mouth with a plastic bag and secure it. When first disinfection is complete (see Section 4.2.4) spray the outside of the silo with disinfectant. Place two 25 kg sacks of a desiccating agent (calcium chloride "quicklime") in the top of the silo to preserve the contents. However, if epidemiological investigations suggest that a food supply is contaminated, the silo must be completely emptied, the contents buried and the inside and outside of the silo disinfected.

It may be feasible to use formaldehyde gas in this situation, depending on the construction of the silo outlet and whether it can be completely sealed (see Section 3.2.5 and Appendix 3)

5.3.4 Feed in sacks

Depending on the nature of the disease agent, opened sacks of feed or feed in hessian sacks may be deemed contaminated and destroyed after valuation. Porous sacks of feed should always be destroyed when the disease agent is easily transmissible or resistant. Porous sacks would in this case be considered high risk, as in the future the feed will be exposed directly to susceptible animals. Unopened paper bags can be wiped with disinfectant and restacked in an area which has been disinfected.

5.3.5 Silage clamps

Well made grass silage should have attained a pH of 3–4 but, usually, silage clamps above ground are close to the animals. Silage clamps should be left until first disinfection. Remove 30 cm of the face and top if it is not covered with plastic sheet and bury the scrapings. Spray the exposed surfaces with disinfectant ensuring that cross contamination does not occur with the workers doing the spraying. If the top is covered, estimate possible contamination at the edges of the sheet. If there are gaps, scrape the exposed area, remove the cover from the edges and spray with disinfectant.

When feedstuffs are being dealt with, it should not be policy to destroy everything. Considerable quantities of feed can be safely decontaminated. The decisions must be taken in consultation with the LDCC .

5.4 Specialist equipment on the IP and DCP

On some properties, there is equipment such as control panels, electronic gear, electric motors and computerised equipment, which could be damaged by some of the direct methods of decontamination previously discussed.

5.4.1 Electric motors and switchboards

If there is doubt, then consult an electrical contractor. Consider whether decontamination of such equipment is a priority activity. It is unlikely that covered electrical equipment will be heavily contaminated. Such items are best considered at the end of the decontamination process when specialists can be more readily consulted.

The most practical method of decontamination is to make an airtight 'tent' of plastic sheeting around the equipment or, if the equipment can be easily dismantled, all the separate items can be placed in a small enclosed space for fumigation. Some items will be airtight in which case they can be safely decontaminated by wiping down with disinfectant.

The only other method is to use formaldehyde gas. However, serious consideration must be given to the practical and safety aspects of this procedure (see Section 3.2.5 and Appendix 3). Most exotic viruses will inactivate spontaneously with time. Exposure to sunlight may be a good option for complex equipment.

5.4.2 Radios, tape recorders and cameras on IPs/DCPs

Hand-held radios are useful on an IP. They enable efficient communication between officers in different areas of the IP who are performing integrated tasks. Tape recorders are used by some officers for recording epidemiology and property assessment data. They can also be used as a recording method for damage claims, after destruction of buildings. All the above can be used while secured inside plastic bags. Inexpensive waterproof cameras can be used to record lesions and symptoms.

When required to remove such equipment from the IP the following procedure must be carried out at the decontamination site:

- wipe over the plastic bag and then discard the bag;
- wipe over the body of the instrument with disinfectant; and
- replace in a watertight plastic bag for removal after the bag has again been disinfected.

There is a small residual risk of contamination. For the duration of the outbreak these items of equipment should only be used on specific IPs or DCPs.

5.4.3 Captive-bolt pistols and firearms

These items will be grossly contaminated. After completion of slaughter, the weapons should be scrubbed with disinfectant on the IP. When the weapon requires servicing, it is taken to a gunsmith in a disinfected plastic bag. The weapons should be stripped down for service. The gunsmith is made aware that the mechanism should be disinfected. When decontaminated they are serviced and re-oiled.

If the outbreak of disease includes a number of premises the weapons can be delivered to the next IP after disinfection enclosed in disinfected plastic bags.

APPENDIX 1 Equipment checklist

Personal equipment
Industrial hard hat
Knee length Wellington boots
Fisherman's waders
Plastic jacket and trousers
Cotton overalls
Neck cloth (hand towel)
Torch and batteries
Gloves – industrial
– disposable
Supply of citric acid (1kg in plastic container)
Short-handled scrubbing brush
Boot tray or bucket
Ear protectors
Heavy duty plastic garbage bags
Spare underclothes

Decontamination site — IP or DCP
2 plastic ground sheets (10 m x 10 m)
50 m hessian sacking
Star pickets
Caravan and portable shower units
50 m of 20 mm rope
6 x 200 L drums
Fibreglass water tanks to 2500 L
Water supply
Pumps
Hoses (spray attachments)
Disinfectant supplies (citric acid or sodium carbonate) as appropriate
Hand brushes – short and long handle
Boot trays
Buckets
Heavy duty plastic garbage bags
Spare cotton overalls

Property decontamination
Water supply
Portable pumps,
Polypipe 50 mm
Fittings for pipe
Hoses
High pressure industrial pumps and lances
Fibreglass water tanks of sizes up to 2500 litres
200 L drums
Universal indicator strips
Supply of disinfectant citric acid
sodium hydroxide
sodium carbonate
calcium hypochlorite
soap and detergent
Flame guns and fuel
Fuel for pumps and engines
Generators
Arc lamps
Electric lead and connectors
Mechanical diggers
Bulldozers
Tractor and trailers
Front-end loaders
Vehicle-mounted boom spray
Shovels
Brooms
Forks
Crowbars
Hand tools

Plastic sheeting
20 L containers (metal)
Industrial gloves
Respirators
Perspex face shields
Ear protectors
Back pack sprays

Vehicle decontamination at LDCC

Road control points

Road and rail transport

Water supply and tanks for storage
Buckets
Detergent and brushes
Supply of citric acid
sodium carbonate
sodium hydroxide for rail transport
Sponges
Tools for dismantling floor – shovels, hand brushes, scrapers
Fire fighting pump
High pressure pump
Fuel for pump engines
Perspex face shields
Personal equipment
Lifting gear for crates
The equipment above will vary with specific circumstances.

APPENDIX 2 Suppliers and distributors of disinfectants

This manual recommends disinfectants that are effective against viruses as most exotic disease agents of concern are viruses. It concentrates on well known chemicals rather than trade names.
The eight major disinfectants listed have been chosen for the following reasons.

1) They are effective against viruses in most of the conditions expected to be encountered on a property during an exotic disease outbreak.

2) Most are widely available from hardware stores as general-purpose chemicals (sodium hydroxide, sodium carbonate, hydrochloric acid), swimming pool disinfectants (sodium and calcium hypochlorite), or general laboratory chemicals.

3) Most are relatively inexpensive, the exceptions being glutaraldehyde and Virkon®.

4) Most are available in large quantities to facilitate use in large-scale outbreaks.

5) All are available as powders or as concentrated liquids to allow easy transportation to an infected property followed by appropriate dilution.

6) Most are effective as technical grade chemicals.

The table below gives suggested suppliers for the major recommended disinfectants. The list is rudimentary and operators responsible in regional areas will be in a better position to identify the best local suppliers.

DISINFECTANT/CHEMICAL	SUPPLIERS (to be added as appropriate for each country)
Citric acid	
Formalin (formaldehyde solution)	
Glutaraldehyde (aidal)	
Hydrochloric acid (spirits of salts)	
Hypochlorites (calcium and sodium)	
Sodium carbonate (washing soda)	
Sodium hydroxide (caustic soda)	
Virkon®	

Key for suppliers:

(to be added as appropriate for each country)

APPENDIX 3 Practicalities of decontamination with formaldehyde gas

There are limited ways that decontamination of large spaces or electronic equipment can be done on rural premises. Formaldehyde gas can be used with limited safety only in certain environments and in the hands of experienced operators.
Effective decontamination with gaseous formaldehyde requires a favourable combination of gas concentration, temperature, relative humidity and contact time. Most usual procedures suggest formaldehyde concentrations of 2–10 g/m^3, relative humidity values of 70%–90% at temperatures of 20^oC for periods of 15 to 24 hours.
Considerations before attempting formaldehyde decontamination:

1) Ensure all surfaces are clean first.

2) An even dispersal of the gas within the enclosed space is essential for uniform decontamination. Electric fans are recommended to assist circulation.

3) Because formaldehyde is a very toxic gas, it must be totally retained within the space to be treated and then effectively neutralised prior to opening. Breathing masks and special equipment for monitoring residual formaldehyde are strongly recommended.

4) Although an elevated relative humidity is necessary for optimal activity, water cannot be present in liquid form as it will dissolve the gas and reduce its effective concentration in the gaseous phase. It is therefore difficult to establish the required relative humidity conditions outside a controlled laboratory situation.

5) An evenly controlled temperature is also essential for effective decontamination. If the temperature of the walls of the vessel/building falls during the decontamination, the formaldehyde will polymerise on them to form a powdery precipitate of paraformaldehyde which reduces the effectiveness of the operation and creates problems of residual toxicity. Such conditions are likely to occur in farm buildings or vehicles during overnight decontaminations.

6) Formaldehyde will react with free chlorine or chlorides (eg hypochlorites or hydrochloric acid) to produce carcinogenic compounds, which are a potential danger.

7) Environmental release of formaldehyde is prohibited by most regulatory health agencies.

8) Mixtures of formaldehyde with air are explosive, so risks associated with fire and explosions are substantial.

Notwithstanding the problems associated with formaldehyde decontaminations, there are two possible ways of generating the gas in non-laboratory situations.

Formalin solution (20 mL/m^3 space) can be mixed with potassium permanganate (16 g/m^3), a violent reaction that produces heat and boiling and is potentially dangerous. Large vessels (ten times the volume of the formalin) must be used to contain the boiling reaction. A number of smaller vessels is preferable, each of which must be in a metal tray and well clear of combustible material. The enclosure must be prepared in advance so the operator, wearing protective clothing and a full face respirator, can mix the ingredients and leave the enclosure quickly. A second person equipped similarly, must wait at the open door to ensure no mishaps occur. The last action in the enclosure must be to add the pre-measured formalin to the potassium permanganate in each reaction vessel commencing with the vessel furthest from the exit door.

Alternatively, paraformaldehyde powder may be sublimed by heating at 200^{o}C in an electrically heated device such as a frypan to produce an active concentration of 5 g/m^3. This method is safer than the former, but requires a remote controlled method of supplying the heat.
Formaldehyde gas can be neutralised by reaction with ammonia gas produced by heating ammonium carbonate (7.5 g/m^3 space) at 120^{o}C after the decontamination is complete. Again, a satisfactory remotely-controlled heating device is required. Ventilation of the space must be done thoroughly upon completion of the decontamination and neutralisation process.

In summary, gaseous formaldehyde decontaminations should only be done by experienced personnel with appropriate safety equipment. It is recommended only if no suitable alternative options are available to achieve the desired result.

GLOSSARY

Agent	*see* Disease agent
Amplification (of virus)	Increase in the amount of virus. Some infected animal species produce much larger amounts of virus than others, these are known as amplifying hosts.
Animal by-products	Meat products and products of animal origin (eg eggs, milk) for human consumption or for use in animal feeding.
Animal products	Meat products and products of animal origin (eg eggs, milk) for human consumption or for use in animal feeding.
Control area	A bigger area than a restricted area (possibly initially as big as the state) where restrictions will reduce the chance of the disease spreading further afield. The control area may reduce in size as confidence about the extent of the outbreak becomes clearer but must remain consistent with OIE codes . In principle, animals and specified product will only be able to be moved out of the control area into the free area by permit.
Dangerous contact animal	An animal showing no clinical signs of disease but which, by reason of its probable exposure to disease, will be subjected to disease control measures.
Dangerous contact premises	Premises that contains a dangerous contact animal(s).
Declared area	A defined tract of land for the time being subject to disease control restrictions under exotic disease legislation. Types of declared areas include restricted area; control area; infected premises; and dangerous contact premises
Disease agent	The organism that causes the disease.
Disposal	Sanitary removal of animal carcasses and things by burial, burning or some other process so as to prevent the spread of disease.
Exotic animal disease	A disease affecting animals that does not normally occur in the country. Also called foreign animal disease.
Forward command post	A field operations centre, subsidiary to a Local Disease Control Centre.
Enterprise	*see* Risk enterprise
Infected premises	A defined area (which may be all or part of a property) in which an exotic disease or agent exists, is believed to exist.
Job card	A written list of tasks to be carried out by an individual in the early stages of an emergency response.
Lipid envelope	*see* Viral envelope
Local disease control centre	An emergency operations centre responsible for the command and control of field operations in a defined area.
Movement control	Restrictions placed on movement of animals, people and things to prevent spread of disease.
OIE Code	International Animal Health Code 1992 (*see* References)
Quarantine	Legal restrictions imposed on a place, animal, vehicle or other things limiting movement.
Restricted area	A relatively small declared area (compared to a control area) around an infected premises that is subject to intense surveillance and movement controls. Movement out of the area will in general be prohibited, while movement into the restricted area would only be by permit. Multiple restricted areas may exist within one control area.
Risk enterprise	Livestock-related enterprise with a high potential for disease spread or economic loss.
Role description	Statement of functions of a position within the overall operation.
Sentinel animals	Animals of known health status monitored for the purpose to detect the presence of a specific exotic disease agent.
'Setting' (meat)	The hardening of carcasse tissue during the process of chilling, immediately following slaughter.
Silage clamps	Structure in which silage is stored.
Slurry tank	A tank that contains a suspension of solids in liquid, usually animal manure.
Stamping out	Eradication procedures based on quarantine and slaughter of all infected animals and animals exposed to infection.
Surveillance	A systematic examination and testing of animals or things to determine the presence or absence of an exotic disease.
Suspect animal	An animal which may have been exposed to an exotic disease such that quarantine and intensive surveillance, but not pre-emptive slaughter, are warranted; or, an animal not known to have been exposed to a disease agent but showing clinical signs requiring differential diagnosis.
Suspect materials or things	Materials or things suspected of being contaminated by an exotic disease agent.
Suspect premises	Premises containing suspect animals which will be subject to surveillance.

Swill	Food scraps of placental mammal origin that have not been obtained from approved slaughter facilities or treated by an approved process.
Swill feeding	Swill feeding is the feeding of swill to pigs; unlicensed swill feeding is illegal in Australia.
Tracing	The process of locating animals, persons or things which may be implicated in the spread of disease.
Vector	A living organism (frequently an arthropod) that transmits an infectious agent from one host to another. A *biological* vector is one in which the infectious agent must develop or multiply before becoming infective to a recipient host. A *mechanical* vector is one that transmits an infectious agent from one host to another but is not essential to the life cycle of the agent.
Vector control area	An area in which the containment, control or reduction of specified vector populations is conducted.
Viral envelope	The lipoprotein outer covering of virions of some viruses, derived from cellular membranes but containing virus-specific proteins, usually glycoprotein peplomers.
Zoning	The process of defining disease free and infected area in accord with OIE guidelines, in order to facilitate trade.
Zoonosis	A disease that can be spread between animals and people.

Abbreviations

CA	Control area
CVO	Chief veterinary officer
DCP	Dangerous contact premises
IP	Infected premises
LDCC	Local disease control centre
NDCHQ	National disease control headquarters
OIE	World Organisation for Animal Health [Office International des Epizooties]
PDS	Personal decontamination site
RA	Restricted area
SIT	Sterile insect technique

References

Dychdala, G.R. (1991). Chlorine and chlorine compounds. In *Disinfection, Sterilization, and Preservation,* 4th edition (ed. by S.S. Block), Lea & Febiger, Philadelphia & London, p. 131-151.

Geering, W.A., Forman, A.J. and Nunn, M.J. (1995). *Exotic Diseases of Animals: A Field Guide for Australian Veterinarians,* Bureau of Resource Sciences, Australian Government Publishing Service, Canberra.

Klein, M. and DeForest, A. (1981). Principles of virus inactivation. In *Disinfection, Sterilization, and Preservation,* 3rd edition (ed. S.S. Block), Lea & Febiger, Philadelphia & London, p. 422-434.

Kostenbauder, H.B. (1991). Physical factors influencing the activity of antimicrobial agents. In *Disinfection, Sterilization, and Preservation,* 4th edition (ed. S.S. Block), Lea & Febiger, Philadelphia & London, p. 59-71.

Prince, H.N., Prince, D.L., and Prince, R.N. (1991). Principles of viral control and transmission. In *Disinfection, Sterilization, and Preservation,* 4th edition (ed. S.S. Block), Lea & Febiger, Philadelphia & London, p. 411-444.

Quinn, P.J. (1991). Disinfection and disease prevention in veterinary medicine. In *Disinfection, Sterilization, and Preservation,* 4th edition (ed S.S. Block), Lea & Febiger, Philadelphia & London, p. 846-870.

Scott, F.W. (1980). Virucidal disinfectants and feline viruses. *American Journal Veterinary Research,* 41: 410-414.

Scott, E.M. and Gorman, S.P. (1991). Glutaraldehyde. Disinfection and disease prevention in veterinary medicine. In *Disinfection, Sterilization, and Preservation,* 4th edition (ed. S.S. Block) Lea & Febiger, Philadelphia & London, p. 596-616.

Video/training resources

Cleaning it up - decontamination of properties and equipment (video),

AAHL 1993 (available from the Australian Animal Health Laboratory).

[See the Summary Document for a full list of training resources.]

OIE publications

OIE Code (1992). *International Animal Health Code* (6th edition), OIE, Paris, France.
OIE Manual (1992). *Manual of Standards for Diagnostic Tests and Vaccines* (2nd edition), OIE, Paris, France.