

AUSTRALIAN VETERINARY EMERGENCY PLAN

AUSVETPLAN

Disease Strategy **Newcastle disease** **Version 3.3, 2014**

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

Agriculture Ministers' Forum

This disease strategy forms part of:

AUSVETPLAN Edition 3

This strategy will be reviewed regularly. Suggestions and recommendations for amendments should be forwarded to:

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DISEASE WATCH HOTLINE

1800 675 888

The Disease Watch Hotline is a toll-free telephone number that connects callers to the relevant state or territory officer to report concerns about any potential emergency disease situation. Anyone suspecting an emergency disease outbreak should use this number to get immediate advice and assistance.

Preface

This disease strategy for the management of Newcastle disease (ND) in Australia is an integral part of the **Australian Veterinary Emergency Plan**, or **AUSVETPLAN (Edition 3)**. AUSVETPLAN structures and functions are described in the **AUSVETPLAN Overview Document**. The disease strategy provides information about the disease (Section 1); the relevant risk factors and their treatment, and the options for management of a disease outbreak, depending on the circumstances (Section 2); the suggested starting policy and guidelines for agencies and organisations involved in a response to an outbreak (Section 3); and declared areas and premises, and quarantine and movement controls (Section 4).

This manual has been produced in accordance with the procedures described in the **AUSVETPLAN Overview Document** and in consultation with Australian national, state and territory governments, and the poultry industry.

ND is included on the World Organisation for Animal Health (OIE) list of notifiable diseases as an avian disease. OIE-listed diseases are diseases with the potential for international spread, significant mortality or morbidity within the susceptible species, and/or potential for zoonotic spread to humans.¹ OIE member countries that have been free from a notifiable disease are obliged to notify the OIE within 24 hours of confirming the presence of the disease.

The strategies in this document for the diagnosis and management of an outbreak of ND are based on the recommendations in the OIE *Terrestrial Animal Health Code*² and the OIE *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals*.³ The strategies and policy guidelines are for emergency situations, and are not applicable to quarantine policies for imported livestock or livestock products.

In Australia, ND is included as a Category 3 emergency animal disease in the *Government and Livestock Industry Cost Sharing Deed in Respect of Emergency Animal Disease Responses* (EAD Response Agreement).⁴

In this manual, text placed in square brackets [xxx] indicates that that aspect of the manual remains contentious or is under development; such text is not part of the official manual. The issues will be worked on by experts and relevant text included at a future date.

Guidelines for the field implementation of AUSVETPLAN are contained in the disease strategies, operational manuals and management manuals. Industry-specific information is given in the relevant enterprise manuals. The full list of

¹ These criteria are described in more detail in Chapter 1.2 of the OIE *Terrestrial Animal Health Code* (www.oie.int/index.php?id=169&L=0&htmfile=chapitre_1.1.2.htm)

² www.oie.int/index.php?id=169&L=0&htmfile=chapitre_1.10.9.

³ www.oie.int/fileadmin/Home/eng/Health_standards/tahm/2.03.14_NEWCASTLE_DIS.pdf

⁴ Information about the EAD Response Agreement can be found at www.animalhealthaustralia.com.au/programs/emergency-animal-disease-preparedness/ead-response-agreement

AUSVETPLAN manuals that may need to be accessed in an emergency is shown below. The complete series of manuals is available on the Animal Health Australia website.⁵

AUSVETPLAN manuals

Disease strategies

Individual strategies for each of 35 diseases

Bee diseases and pests

Response policy briefs (for diseases not covered by individual manuals)

Operational manuals

Decontamination

Destruction of animals

Disposal

Livestock welfare and management

Valuation and compensation

Wild animal response

Enterprise manuals

Artificial breeding centres

Feedlots

Meat processing

Pig industry

Poultry industry

Saleyards and transport

Zoos

Management manuals

Control centres management
(Parts 1 and 2)

Laboratory preparedness

Overview document

Nationally agreed standard operating procedures⁶

Nationally agreed standard operating procedures have been developed for use by jurisdictions during responses to emergency animal disease incidents and emergencies. These procedures underpin elements of AUSVETPLAN and describe in detail specific actions undertaken during a response to an incident.

⁵ www.animalhealthaustralia.com.au/programs/emergency-animal-disease-preparedness/ausvetplan/

⁶ www.animalhealthaustralia.com.au/programs/emergency-animal-disease-preparedness/nasops

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1 Nature of the disease

Newcastle disease (ND) is a highly contagious, generalised viral disease of domestic poultry, cage and aviary birds, and wild birds. It is usually seen in domestic gallinaceous birds (poultry) as a rapidly fatal, high-mortality condition characterised by gastrointestinal, respiratory and/or nervous signs. In other avian species, the disease produced by virulent ND viruses ranges clinically from inapparent to a rapidly fatal condition. ND viruses have varying capability (pathogenicity) to produce clinical disease in domestic chickens, with some virus strains showing high levels of pathogenicity while other strains produce no disease and are classified as nonpathogenic (avirulent).

1.1 Aetiology and pathogenicity

ND virus is an avian paramyxovirus of type 1 serotype (APMV-1). Overall, there are nine serotypes of APMV (types 1-9).

The many ND virus strains vary widely in virulence and in the tissues affected (tissue tropism). On the basis of the speed with which they kill chickens or chicken embryos under defined conditions, and/or the RNA sequence of the cleavage site of the F0 gene (see below), they are classified as:

- *velogenic* (highly pathogenic, or virulent)
- *mesogenic* (moderately pathogenic)
- *lentogenic* (lowly pathogenic).

Some lentogenic strains of ND virus are considered to be avirulent (asymptomatic enteric).

The virulence of ND viruses is determined by the sequence of the six terminal amino acids at the site where the precursor F0 protein is cleaved to form the F1 and F2 proteins of an infectious virus particle (see Section 1.4.2). Velogenic viruses have an alignment of basic amino acids at this cleavage site that enables the expression of virulent disease in chicken and chicken embryo tests.

ND is a listed disease in the *OIE Terrestrial Animal Health Code* (OIE Terrestrial Code, see Section 3.1). However, not all ND virus infections are considered to be ND for the purposes of classification as an emergency animal disease. Based on the properties of the virus, the OIE has defined ND as an infection of poultry caused by an ND virus of avian paramyxovirus serotype 1 (APMV-1) that meets one of the following criteria for virulence:

- the virus has an intracerebral pathogenicity index (ICPI) in day-old chicks (*Gallus gallus*) of 0.7 or greater; or
- multiple basic amino acids have been demonstrated in the virus (either directly or by deduction) at the C-terminus of the F2 protein and phenylalanine at residue 117, which is the N-terminus of the F1 protein.

The term 'multiple basic amino acids' refers to at least three arginine or lysine residues between residues 113 and 116. Failure to demonstrate the characteristic pattern of amino acid residues as described above would require characterisation of the isolated virus by an ICPI test.

In this definition, amino acid residues are numbered from the *N*-terminus of the amino acid sequence deduced from the nucleotide sequence of the F0 gene, 113–116 corresponds to residues –4 to –1 from the cleavage site.

In Australia, only the second of these two criteria is usually applied (ie classification of ND is based on sequencing of the F0 gene; see Sections 1.4.4 and 2.1).

During replication, ND virus is produced with a precursor fusion glycoprotein F0, which has to be cleaved into F1 and F2 proteins in order for the virus to become infectious. The prime determinant of pathogenicity in ND virus strains is the possession of basic amino acids at least at positions 113, 115 and 116, and phenylalanine at position 117 of the F0 protein. All but one virulent ND virus (pigeon paramyxovirus APMV-1) also has a basic amino acid at position 112. These positions form the cleavage site of the F0 protein and correspond to the C-terminus (116) and *N*-terminus (117) of the F2 and F1 proteins, respectively. If the F0 protein can be cleaved by proteases, which are found in a wide variety of internal organs including liver, spleen, brain, heart and lymphoid tissues, the virus can replicate in a wide variety of organs. The result is systemic infection and the appearance of clinical signs followed by death in most cases.

For viruses of lower virulence, the F0 protein can only be cleaved by trypsin-like enzymes, which are found only on endodermal surfaces, such as in the intestinal and respiratory tracts. This limits replication to these surfaces in the animal. As a distinguishing feature, these viruses also cannot produce plaques in tissue culture without trypsin being added to the overlay medium. To date, using these criteria, only infections with velogenic or mesogenic ND viruses have been classified as ND (Alexander 2000).⁷

Viruses with mutations at the F0 cleavage site of lentogenic viruses have been detected as velogenic viruses in outbreaks of ND in Australia in 1998, 1999, 2000 and 2002. Such outbreaks are classified as *Australian-origin ND infection*. ND infection that is introduced to Australia from an overseas site is classified as *exotic ND infection*.

Australian-origin and exotic ND viruses can be distinguished by definition of the genetic sequence of F0 and HN genes and the length of the HN extension. The distinction between Australian-origin and exotic ND may determine the actions that will be taken in an emergency response.

⁷ In this manual, the term 'Newcastle disease' (ND) is used to describe the emergency animal disease as defined by the OIE. Most ND is caused by velogenic strains (often referred to as 'virulent ND virus'). Although mesogenic virus strains fall within the OIE classification of ND, very few isolations of mesogenic ND viruses have been made worldwide and hence ND-causing strains are unlikely to be mesogenic. In this manual, the term 'virulent ND virus' is used to describe virus strains that cause ND under the OIE definition (ie mainly velogenic, but possibly mesogenic).

1.2 Susceptible species

ND virus is infective for almost all avian species, both domestic and wild. Natural infection has been reported in humans and rodents, and a variety of laboratory animals have been infected experimentally. Infections in non-avian species could spread the disease but the significance of this is not known. However, these animals pose a significant risk because they can act as mechanical vectors of ND.

Chickens

- Highly susceptible to infection with ND virus, including the pigeon variant of APMV-1. Considered to be the most susceptible of domestic poultry species.

Turkeys

- Susceptible to ND. Outbreaks can occur in turkey flocks but they are usually less severe than those in chickens. Effects on egg production are similar to those in chickens. Some outbreaks have resulted in high mortalities, others in leg paralysis.

Pigeons

- Susceptible to ND. The pigeon variant of APMV-1 can produce up to 80% morbidity, with nervous signs and diarrhoea being the most notable clinical features.

Ducks and geese

- Ducks are reported to be readily infected with ND virus and to be capable of spreading the virus. There are few reports of clinical ND virus in ducks. Geese can also be infected with the virus, but are apparently not very susceptible to disease.

Peafowl, guinea fowl, pheasants and quail

- All are susceptible to natural ND virus infection. Although mortalities have been recorded, infection usually produces only mild disease unless it occurs in quail, which are very susceptible.

Canaries

- Susceptible to infection, which usually produces mild or inapparent disease. However, 20–30% mortalities have been recorded in experimental infections in which nervous signs predominated.

Psittacines

- Very susceptible to ND (budgerigars are more susceptible than canaries). Nervous signs usually predominate when there is clinical disease.
- Tropical parrots form a reservoir of virulent ND virus and have been responsible for a number of introductions to the United States. Infected psittacines can excrete virus for at least one year.

Ratites

- Susceptible to infection but are probably fairly resistant to developing clinical signs.

- In an outbreak in Israel, 13 of 46 ostriches aged 5–9 months died with typical nervous signs of ND. The virulent Israel-67 strain of ND virus was isolated (Samberg et al 1989).
- In 1993, three outbreaks occurred on ostrich farms in South Africa. The mortality rate was low and limited to a particular group or camp.

Wild waterfowl

- Another reservoir of avirulent ND viruses usually associated with intestinal infection. However, wild waterfowl have been strongly implicated in the spread of outbreaks across Europe. Infections have occurred in cormorants in the United States and Canada over a number of years without infecting domestic poultry.

Humans

- Humans exposed to ND virus may suffer headache and flu-like symptoms and can develop conjunctivitis, which is usually mild and persists for 1–2 days. Occasionally, the conjunctivitis can become quite severe and even lead to some lasting impairment of vision. The incubation period is reported to be 6–7 days.
- Most infections have occurred among laboratory workers who handle the virus in research or vaccine production laboratories. Vaccinators and individuals who eviscerate and prepare poultry for market may also become infected. Person-to-person transmission of ND virus has not been reported.

Rodents

- Rodents harboured ND virus in a 1974 outbreak in California (Johnson 1974).

1.3 World distribution and occurrence in Australia

The disease was first observed on the Indonesian island of Java in 1926 and later that year spread to Newcastle in the United Kingdom, where it was first recognised and named as a different disease from fowl plague (highly pathogenic avian influenza). Strains of ND virus are present in most countries. There have been three major panzootics of viscerotropic velogenic ND (see Section 1.4.1) since the disease first came to international attention in 1926, the most recent being in the 1980s (Alexander 1988). Outbreaks across Europe in the early 1990s and the United Kingdom in 1996 and 1997 probably originated from infected migratory birds.

Virulent ND virus was absent from Australia, following eradication of outbreaks in 1930 and 1932 in Victoria, until the 1998 outbreak of Australian-origin ND in New South Wales. New Zealand and Papua New Guinea remain free of pathogenic ND viruses. West Papua (formerly Irian Jaya), a province of Indonesia, is the closest area to Australia where ND is endemic. All of Indonesia, East Timor and Southeast Asia have endemic ND.

Avirulent strains are endemic in Australia; the prototype of these strains, designated 'V4', was identified in Queensland in 1966 and rapidly spread across Australia (Simmons 1967). The virulence of the V4 strain is very low. Since 1966, a variety of avirulent and lentogenic strains has emerged in Australia, such as the

Peats Ridge virus detected in New South Wales in 1998 (which had two base pairs different from the parent lentogenic virus). Further mutations in one or more of these precursor strains led to the emergence of the virulent ND viruses in 1998 to 2002 in the Sydney Basin, Mangrove Mountain and Tamworth areas of New South Wales and Meredith in Victoria.

Since the disease outbreaks of 1998 to 2002, it has become necessary to differentiate ND outbreaks that have arisen from mutations of Australian lentogenic viruses (*Australian-origin ND*) and outbreaks that might occur from incursions of virulent ND viruses of overseas origin (*exotic ND*) infecting Australian poultry.

1.4 Diagnostic criteria

For terms not defined in the text, see Glossary.

1.4.1 Clinical signs

The clinical signs of ND virus infection are very variable, influenced greatly by the virulence and tissue tropism of the virus; the species, age, immune status and condition of the bird; the route of exposure; the magnitude of the infecting dose; and external factors, such as type of housing and environmental and social stress. Nevertheless, clinical ND has been broadly classified into four syndromes, based on the disease in domestic chickens:

- *velogenic*
 - *viscerotropic velogenic* – high mortality; haemorrhagic enteritis is the predominant lesion
 - *neurotropic velogenic* – high mortality; respiratory and nervous signs predominate;
- *mesogenic* – low mortality; respiratory signs usually predominate;
- *lentogenic* – mild, predominantly respiratory disease or subclinical infection; and
- *avirulent* – no noticeable clinical signs of infection.

The viruses responsible for these forms of the disease have been similarly grouped by pathotype, but these pathogroups are not clear-cut and considerable variation in clinical signs occurs within them, especially when the condition is complicated by other pathogens or environmental factors. Infections caused by viruses of velogenic or mesogenic type (virulent ND viruses) fulfil the OIE criteria for listing (see Section 1.1).

An outbreak of ND in chickens may be so severe that almost all birds of an affected flock die within 72 hours without noticeable signs, often causing a suspicion of poisoning. In adult layers, a marked drop in production may be the first sign, followed in 24–48 hours by mortality, which can reach 100%. Clinical signs noted may be:

- a sudden drop in egg production often accompanied by production of abnormal eggs (misshapen, soft or missing shells with loss of normal pigment);
- loss of appetite, fever, weakness;
- swelling and cyanosis of the comb and wattles;
- watery, bile-stained, distinctive bright green or bloody diarrhoea;
- respiratory signs, which may include increased respiratory rate, respiratory distress, coughing and a high-pitched sneeze ('snick'); and
- nervous signs, which can include loss of balance, circling, backward progression and convulsive somersaulting, rhythmic spasms, stiff and wry neck, head tremors, and wing and leg paralysis (for further details see Geering et al 1995).

The expected high rates of morbidity and mortality and distinctive clinical signs usually seen with exotic ND outbreaks were often not seen in the Australian-origin outbreaks from 1998 to 2002. The most frequently seen clinical signs, singly or in combination, were depression, nervous signs such as ataxia, paralysis, abnormal posture (opisthotonus) and head nodding, increased mortality and changes to egg shell colour.

1.4.2 Pathology

Gross lesions

Young chickens, or those dying from the peracute form of the disease (causing very rapid death), may not have any gross lesions.

In the viscerotropic form, oedema of the interstitial tissues of the neck, especially near the thorax, may be marked. Haemorrhages occur in the trachea, corresponding to the rings of the cartilages, and in the proventriculus, gizzard, Peyer's patches, caecal tonsils and other aggregations of lymphoid tissue in the intestinal wall. Lesions in the gastrointestinal tract progressively become oedematous, haemorrhagic, necrotic and finally ulcerative. Small, flat, red or purple (petechial) haemorrhages may be seen on the breast muscle, heart muscle and peritoneal adipose tissue and on serosal surfaces.

In the neurotropic form, there is usually a severe haemorrhagic inflammation of the trachea, although it is rare to see free blood in the lumen. Such lesions were not seen in the Australian-origin outbreaks from 1998 to 2002. Haemorrhagic lesions sometimes occur in the proventriculus, but rarely in the rest of the alimentary tract. Gross lesions may not be present in birds that show only nervous signs.

Birds that are partially immune to ND will have gross lesions that are less severe with increases in the birds' degree of immunity.

Pathological changes were absent or subtle in many chickens during the 1998–2002 Australian-origin ND outbreaks.

Microscopic lesions (histopathology)

Histologically, brain lesions are of value in diagnosis. There is neuronal degeneration, gliosis, perivascular lymphocytic infiltration and, very characteristically, hyperplasia of vascular endothelium. Necrosis of the endothelial lining of blood vessels, thrombosis, oedema and haemorrhages may be seen in all organs. There may also be pronounced oedema and cellular infiltration of the submucosa of the nasal tract and trachea, and of the lungs and air sacs (Geering et al 1995).

In the 1998–2002 Australian-origin ND outbreaks, there was multifocal perivascular lymphocyte cuffing, particularly in the brain stem, and sometimes multifocal gliosis and areas of neuronal necrosis.

1.4.3 Laboratory tests

Specimens required

Samples should be taken both from live, clinically affected birds and from recently dead birds. Serum, cloacal and tracheal swabs in virus transport medium or phosphate buffered glycerol saline, and/or fresh faeces should be taken from live birds. From dead birds, alimentary tract tissues (proventriculus, intestine, caecal tonsil), respiratory tissues (trachea, lung) and neurological tissues (brain), as well as heart and kidney, should be collected.

Transport of specimens

Specimens should initially be sent to the state or territory diagnostic laboratory. They will then be forwarded to the CSIRO Australian Animal Health Laboratory (CSIRO-AAHL), Geelong, for emergency disease testing, after the necessary clearance has been obtained from the chief veterinary officer (CVO) of the state or territory of the disease outbreak and after the CVO of Victoria has been informed about the transport of the specimens to Geelong.

Unpreserved tissue and blood specimens should be forwarded with water ice or frozen gel packs (dry ice or liquid nitrogen if a delay of more than 48 hours is expected) in an IATA-approved specimen transport container. For further information, see the Laboratory Preparedness Manual.

Laboratory diagnosis

Tests currently available at CSIRO-AAHL are shown in Figure 1.1 and Table 1.1.

Although a wide variety of serological tests for ND virus are available, including enzyme-linked immunosorbent assays (ELISA) and haemagglutination inhibition (HI) tests, the performance of these assays varies and not all are suited to routine diagnostic use. The HI test is currently the most widely used and produces very few false positive reactions with fowl sera not exposed to ND virus.

The value of serology in diagnosis depends on the expected immune status of the flock and serological titres need to be interpreted cautiously. Although positive serology indicates that a response to ND antigen has occurred, it does not provide a reliable guide to the pathotype of any infecting virus(es). Many poultry flocks in Australia seroconvert due to vaccination, or to infection with low pathogenicity or avirulent ND viruses.

The usual approach to ND diagnosis is screening by real-time PCR. Any positives are further characterised by culture in eggs and by further molecular (genetic) analysis. Analysis of viral genetic sequence data allows assessment of pathogenicity (see below) as well as more detailed phylogenetic analysis. Isolates obtained from egg culture are identified antigenically by HI as well as with molecular tools.

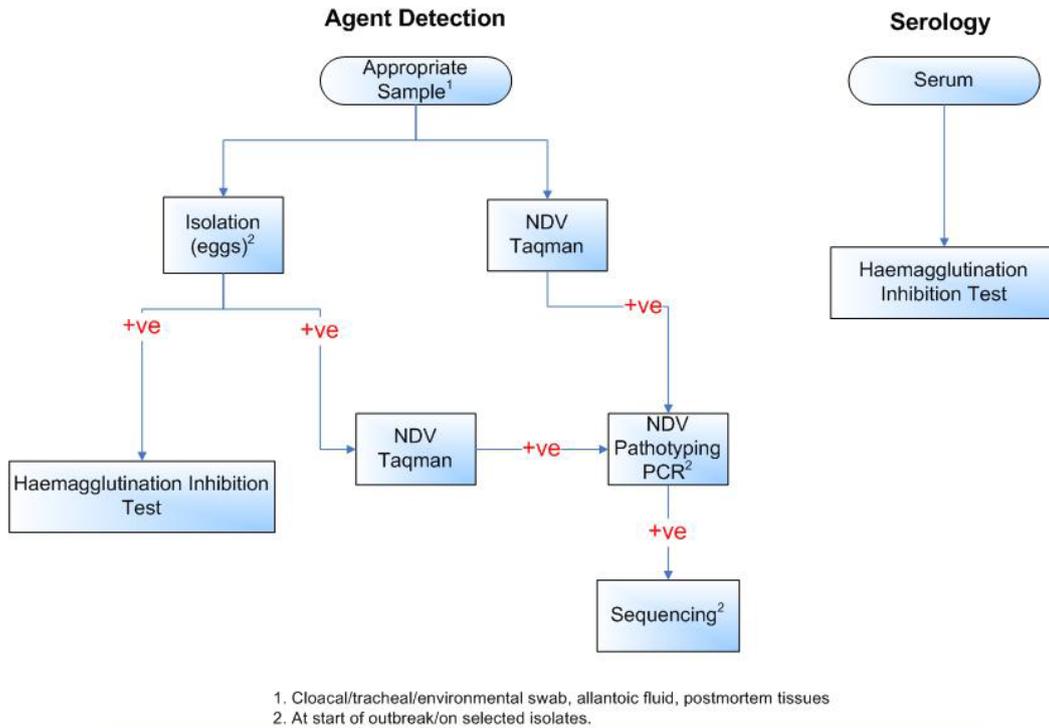


Figure 1.1 AAHL Newcastle disease testing algorithm

Table 1.1 Laboratory tests currently available at CSIRO-AAHL for the diagnosis of Newcastle disease

Test	Specimen required	Test detects	Time taken to obtain result
Agent detection			
qRT-PCR	Swabs, tissues or cultured virus	viral RNA	4 hours
Immunohistochemistry for antigen detection	fresh and formalin-fixed tissues	viral antigen	2–3 days
	paraffin tissues	viral antigen	1 day
Electron microscopy and immuno- EM	Tissues, culture material	virus	1 day
Agent characterisation			
Virus isolation and identification	tissues	virus	2–4 days
RT-PCR and sequencing	Swabs, tissues or cultured virus	viral RNA	2–3 days
PCR Pathotyping	Swabs, tissues or cultured virus	virulence	1 day
Intracerebral pathogenicity index (ICPI)	virus isolated in eggs	virulence	5 days
Serology			
Haemagglutination inhibition	serum	antibody	6 hours
ELISA	serum	antibody	8 hours

ELISA = enzyme-linked immunosorbent assay

RT-PCR = reverse transcription polymerase chain reaction

qRT-PCR = Real time RT-PCR

Source: Information provided by CSIRO-AAHL, 2010 (refer to CSIRO-AAHL for most up-to-date information).

Tests for pathogenicity

The extreme variation in virulence between strains of ND virus, the widespread, but variable, occurrence of low pathogenicity strains in Australia and the use of live virus vaccines mean that the isolation of ND virus from a bird showing clinical signs of ND does not confirm a diagnosis of ND. An estimate of the virulence of the isolate is therefore required to differentiate between vaccine, endemic avirulent, Australian-origin virulent and exotic virulent strains. This is usually based on one or more pathogenicity tests. The OIE recommends two tests (OIE Terrestrial Manual):

- Polymerase chain reaction (PCR) pathotyping test.
- Intracerebral pathogenicity index (ICPI) in day-old chicks

In Australia, the main test used is the PCR test. The ICPI is very rarely used. PCR pathotyping is based on analysis of the derived amino acid sequence of the cleavage site of the viral F0 glycoprotein.

1.4.5 Treatment of infected animals

Treatment of birds with ND is ineffective.

1.5 Resistance and immunity

1.5.1 Innate and passive immunity

Different strains of chickens vary in their response to ND infection. Younger birds develop clinical signs more quickly and are more severely affected, although chicks from immune hens may be protected by antibody derived from the yolk.

1.5.2 Active immunity

It is likely that the bird's full range of immune mechanisms is involved in the immune response.

Cell-mediated immunity can be demonstrated two days after infection. All ND virus strains cause an antibody response in chickens and other avian species. However, titres in cage and aviary birds following natural infection with lentogenic strains are not known. Serum antibody can be detected in chickens 6–10 days after infection. Titres peak after 3–4 weeks and decline to undetectable levels in 8–12 months. Neutralising antibody protects chickens, chicken embryos and cell cultures from infection. Birds resistant to infection have high levels of circulating antibody. Low levels of antibody may not prevent infection but can protect chickens from severe disease and mortality. It has been demonstrated that vaccinated birds without detectable antibody may survive challenge with virulent virus. This may be due to low levels of humoral antibody, interference between vaccine and challenge virus competing for cell attachment sites, cell-mediated immunity, and/or local immunity.

Resistance to ND virus infection may be evoked by previous inapparent infection with avirulent virus such as the V4 strain. Some Australian flocks are partially or totally immune due to exposure to lentogenic and avirulent strains of ND virus. It is possible that infection could be subclinical, smoulder and become widely disseminated before being diagnosed.

1.5.3 Vaccination

Vaccine-induced immunity is short-lived: it is currently considered to last 10–12 weeks. To maintain adequate protection, repeated vaccinations are needed. Parental immunity also interferes with vaccine effectiveness. Vaccination programs are therefore often delayed until chicks are 1–2 weeks old.

Both naturally occurring ('live') and inactivated ('killed') vaccines have been developed overseas and experiments conducted locally and overseas to determine the vaccine effectiveness of the lentogenic V4 strain (Australian virus isolated in 1966). Lentogenic virus vaccines are generally administered by eye drop, in drinking water, by aerosol or intranasally. A vaccine using a heat-tolerant V4 strain has been developed for feeding to village chickens in countries where these constitute a significant proportion of poultry production.

Mesogenic strains are not considered for use in Australia because the vaccine virus is capable of causing significant disease in fully susceptible poultry. Vaccines based on lentogenic strains of virus, such as B1, La Sota, F and V4, which have proven efficacy against ND, have been successful in controlling ND outbreaks in many parts of the world.

The advantages of vaccination with live vaccines arise from their relative inexpensiveness, stimulation of local immunity and ease of application through mass medication, as well as from their ability to protect soon after vaccination. The disadvantage of live lentogenic virus vaccines is their capacity to produce disease in association with complicating infections such as infectious bronchitis and other respiratory infections; for this reason, very lowly pathogenic viruses are used for initial vaccination and this, in turn, requires multiple vaccination. The efficacy of lentogenic virus vaccines depends on the ability of the vaccine virus to multiply in chickens and stimulate immunity, particularly in the face of maternal immunity. Their ability to spread from bird to bird is also important in exposing all birds to infection. The V4 strain vaccine has not been reported to have produced disease or affected egg production in vaccinating flocks.

Oil-based, inactivated vaccines are widely used and are usually injected intramuscularly. These vaccines have been used where ND is endemic, to revaccinate laying and breeding birds previously vaccinated with a lentogenic vaccine. The double vaccination is claimed to produce a stronger and more durable immune response. Revaccination close to the point of lay, using an oil-based, inactivated vaccine is said to protect the bird for the whole of the laying period. Simultaneous use of 'living' B1 oral spray and subcutaneous oil-based inactivated vaccine has protected chickens vaccinated as day-old chicks for 12 weeks. Similarly, Arzey and Pearce (2001) demonstrated that simultaneous use of V4 and inactivated La Sota vaccine produced mean HI titres of 2^7 , range 2^5 to 2^{11} , for a period of up to three months.

Field vaccination trials have shown that V4 strain vaccine may be effectively administered en masse to Australian chickens housed under commercial conditions on litter. Layers in cages can be vaccinated with a combination of live V4 water vaccination and live V4 intramuscularly (Arzey and Arzey 1999) or live V4 water vaccination and inactivated vaccine (Arzey and Pearce 2001). Aerosol vaccination has provided protection against challenge with a viscerotropic velogenic ND virus (Bell et al 1991). Westbury et al (1984) demonstrated a shorter period and reduced frequency of excretion of virulent ND virus following vaccination with inactivated V4 vaccine. However, there are no published reports of similar studies following vaccination with live V4 vaccine strains. It is known that birds vaccinated with other vaccines can excrete virulent virus after challenge. Infection in such birds is likely to significantly boost antibody titres.

Vaccination with V4 strain virus was used in 1999 in Australia when the Peats Ridge precursor virus was detected in the Mangrove Mountain area of New South Wales in chicken flocks two to three months after restocking of depopulated and disinfected properties. Vaccine was used to suppress the spread of Peats Ridge virus in the hope that infection with Peats Ridge virus and Somersby variant viruses would ultimately be eradicated in the Mangrove Mountain area. Vaccination with V4 virus was also used on layer poultry farms infected with endemic virulent ND viruses outside the Mangrove Mountain area to suppress and eradicate Australian-origin virulent ND and precursor viruses prior to the slaughter out of these flocks in 2001. A national survey for ND viruses in 2000 did not detect Peats Ridge, virulent or other precursor viruses in New South Wales or the rest of Australia. Further surveillance in 2001 has found precursor viruses of the Peats Ridge type on a small number of properties that had not vaccinated and which were in areas where virulent ND virus had been detected.

It is not known whether compulsory vaccination with V4 strain in an area will eliminate infection with other ND strains, although blanket vaccination with La Sota and other vaccines has been capable of eliminating infection in countries with exotic ND viruses. The strategy requires effective vaccination, protection against reintroduction of virulent ND infection, and tighter biosecurity on individual farms.

1.6 Epidemiology

After the outbreaks of ND in the United Kingdom in the 1960s and early 1970s, the spread of the virus was reported by the British to be significantly by wind (Dawson 1973). This was reinforced by comments by J McFerran (pers comm, 1988) on the outbreaks in Northern Ireland. However, in other outbreaks in the 1970s, 1980s and 1990s, airborne spread of velogenic ND has been ascribed a low importance compared to the movement of birds, humans, equipment, vehicles and other fomites. The importance of these latter routes of transmission relates to the ready demonstration of ND transmission by faeces as opposed to relatively little experimental evidence for the spread of infection by aerosol (Alexander 2000). Nonetheless, where poultry farms are concentrated in a region and climatic conditions are favourable, it is difficult to conclude that airborne spread will not play a role.

The stability and persistence of ND virus in faeces are well established (see Section 1.6.2).

Transmission studies with Australian-origin ND viruses have demonstrated low transmissibility in the laboratory compared with exotic strains of ND viruses, suggesting that bird, human and fomite movements and windborne spread of contaminated chicken debris and litter from infected flocks are likely to be the major reasons for the spread of Peats Ridge family viruses and Australian-origin ND viruses.

1.6.1 Incubation period

The incubation period is usually 2–6 days in domestic fowls, but can be up to 15 days. It is generally shorter for younger birds. The OIE defines the maximum incubation period, for the purposes of the Terrestrial Code, as 21 days.

During the incubation period, the virus replicates at the site of introduction. Virulent and mesogenic viruses are then discharged into the bloodstream where they replicate in the visceral organs. Another release into the bloodstream, about two days after infection, coincides with the excretion of virus via the respiratory tract and in the faeces. Clinical signs occur 24 hours later. The clinical signs observed will be determined by the tropism of the virus. Infection with the lentogenic viruses remains on the epithelial surfaces.

1.6.2 Persistence of agent

General properties

- Compared with most paramyxoviruses, ND virus is relatively heat stable, a feature of great importance in relation to its epidemiology and control (Fenner et al 1987):

- it remains infectious in bone marrow and muscles of slaughtered chickens for at least six months at -20°C and for up to four months at refrigerator temperatures;
 - infectious virus may survive for months at room temperature in eggs laid by infected hens, and for over a year at 4°C ; and
 - similar survival times have been observed for virus on feathers, and virus may remain infectious for long periods in contaminated premises.
- The virus is more susceptible to the action of alkali than to acid.
 - The presence of lipid in the ND virus envelope makes it highly susceptible to disinfectants containing detergents (see Section 2.2.8).

Environment

- Direct sunlight inactivates the virus in 30 minutes (Buxton and Fraser, cited in Lancaster 1981).
- The persistence of exotic ND virus in waterways is not known but the disease does not appear to spread as readily through contaminated water as does avian influenza. However, there is potential for the spread of virus in contaminated water as virus can survive in water for periods ranging from 32 hours to 19 days, depending on temperature.

Wild birds

Waterfowl

- Waterfowl can excrete virulent ND virus for up to six weeks, although they are generally refractory to clinical disease; cormorants in Canada and the United States have maintained virulent ND virus infections over many years (Alexander 2000).
- Generally, the ND virus strains isolated from waterfowl are of the avirulent type associated with intestinal infections (Alexander 2000).

Psittacines

- Psittacines have been shown to excrete virulent virus for up to a year and initiated ND panzootics in various parts of the world in the 1970s. The potential of ND to be spread to susceptible poultry by wild psittacines should not be underestimated (Erickson et al 1977).

Pigeons

- Pigeons were responsible for spreading a particular strain of APMV-1 virus across Europe in the 1970s. This virus had some antigenic differences from classical strains (Alexander 2000) and this appears to be the only panzootic in which pigeons played a major role in the spread of disease.
- Pigeons excrete virus in the faeces during the acute phase of the disease after infection with viscerotropic velogenic ND virus but not during convalescence.

- Virus persists for four weeks in the trachea and lungs and up to five weeks in the brain.
- The birds do not become inapparent carriers, and excrete virus for only a relatively short time.
- Pigeons experimentally infected with a lentogenic virus can develop mild respiratory signs and conjunctivitis six days later and excrete virus for 3–7 days (Videvogel and Duchatel 1986).
- Pigeons had close contact with one infected flock in New South Wales but did not develop clinical signs or serological responses to Australian-origin ND viruses.

Pheasants, partridges, turkeys and quail

- Game birds have all been involved in ND outbreaks, some of which resulted in spread of disease to domestic poultry.

Ratites

- In outbreaks of ND in Israel and South Africa, disease spread was limited to isolated groups of ostriches.

Native Australian birds

- Numerous native Australian avian species have been shown to be susceptible to ND (Bains 1993, Gilchrist 1993). However, they are probably not important in dissemination. Serological surveillance of 1235 samples from 130 bird species in Queensland demonstrated no infection with ND. No evidence of ND infection was found in birds sampled during the 1998–2000 outbreaks in New South Wales.

Mammals

Mammals, other than humans and rodents, have not been reported to become infected with ND viruses and their role in the dissemination of ND is confined to mechanical transmission.

Live poultry

Virus is present in most tissue secretions and excretions of acutely infected birds from 24 hours before clinical signs appear and throughout the clinical disease stage and death. It is generally reported that virus can be recovered from poultry for at least seven days after infection.

Carcases

Virus remains viable in the carcasses of birds until decomposition is well advanced. It is stable in nonputrefying tissue and organ samples or faeces if not exposed to high temperatures and has been isolated from bone marrow held for several days at 30°C (Omojola and Hanson 1986).

Birds slaughtered for meat during an outbreak can be a significant source of virus. Most body organs contain virus at some time during infection. Infectious virus has been recovered from meat after 250 days at -14°C to -20°C and from skin and bone

marrow after 250 days at -4°C (Asplin 1949). In overseas outbreaks, frozen meat products have been a significant means of spread, especially when uncooked poultry scraps have been fed to poultry. Virus in fresh and frozen poultry meat is of concern in outbreaks. Packaging and the drip that develops during storage are also important, as both can be contaminated with virus from infected carcasses (Lancaster and Alexander 1975). Despite these features, the importance of infected carcasses in the spread of ND in outbreaks in the 1980s and 1990s has been minimal (Alexander 2000).

Meat products

Virus can persist in fresh and frozen poultry meat products. There is evidence that feeding of uncooked poultry offal and scraps to susceptible birds helped to spread the disease in the Melbourne outbreaks of 1930 and 1932 (Arzey 1989). Untreated poultry offal and poultry scraps are not fed to commercial poultry in Australia.

Cooked and partially cooked poultry meat products include nuggets, crumbed chicken pieces, schnitzel, loaves, roasted chicken, offal and meatmeal. The ability of ND virus strains to maintain infectivity under various heat regimens varies considerably between strains. For example, stability at 56°C varies from five to 240 minutes (Arzey 1989).

The generic import risk analysis conducted by Biosecurity Australia required that, to ensure the destruction of ND virus, chicken meat need to be heated to a minimum core temperature of 70°C for at least 8 minutes and 12 seconds, or for equivalent time and temperature (Biosecurity Australia 2008).

The actual cooking temperatures and times used for poultry products are shown in Table 1.2.

Table 1.2 Cooking temperatures and times for various poultry products

Product	Temperature ($^{\circ}\text{C}$)	Time	Temperature inside product ($^{\circ}\text{C}$)
Nuggets			
– fully cooked	210	1 minute (average)	75
– partially cooked ^a	196–207	27 seconds	-1^{b}
– further cooking at fast-food outlets	182	10–15 minutes	85
Roast chicken			
– chicken loaf	215	60 minutes	85–90

Source: Arzey (1989)

^aFlash fried

^bNuggets are held at -1°C before partial cooking and then subjected to a short period at a high temperature. They are further cooked at fast-food outlets.

Industry sources claim that precooked products for the retail market (such as roasted and smoked poultry and poultry rolls) and secondary products (such as poultry stock cubes, soup mixes, and canned and dried pet foods) all satisfy the minimum core temperature requirements. However, for flash-fried products, such as nuggets, the cooking time is so short that the internal temperature is unlikely to be raised sufficiently to kill the virus. Further cooking at fast-food outlets, however, is sufficient to kill the virus. The virus may also survive in fully cooked

nuggets, as they only reach a core temperature of 75°C for one minute. However, fully cooked nuggets are recooked by the consumer before serving.

Poultry meat was incriminated as the major means for the introduction and spread of ND in the United Kingdom in the 1940s to 1960s and 66% of imported poultry meat yielded virus infection (Dawson 1973). Spread of disease resulted when poultry waste was fed to poultry. In 2000, feeding such waste to poultry is at a low level, and better hygienic practices in poultry slaughter establishments have greatly reduced the risk of spread from poultry waste (Alexander 2000). This situation has been borne out by the Australian experiences of 1998–2000.

Table eggs and egg products

Although severely affected birds cease to lay, eggs laid in the early phase of an outbreak could carry ND virus internally or on the surface. The virus can penetrate cracked or intact shells or, more significantly, contaminate egg fillers. The survival time on the eggs and fillers is sufficient to allow wide dissemination. Sanitising the eggs, and using new fillers or treating fillers with a sanitiser containing 50–200 ppm of available chlorine or other registered sanitisers, will eliminate the virus from clean surfaces.

Virus recovery from eggs of birds vaccinated 35 days previously has been reported (Tanwane 1971). Laying hens vaccinated with live and inactivated V4 strain vaccines produced high antibody titres and, following challenge with virulent Herts strain, virulent virus was not isolated from the eggs or the chickens (HA Westbury, AAHL, pers comm, 2000). Challenging layers that had been vaccinated once with Herts 33 exotic ND virus strain enabled the isolation of virulent virus from the albumen of one egg and from cloacal swabs. This was not the case in layers vaccinated with the Texas GB strain where virulent virus could not be isolated (P Daniels, AAHL, pers comm, 2003). There are more reports of isolation of lentogenic viruses from eggs than there are reports of virulent virus isolation from eggs.

Egg pulp products are another source of the virus. Current pasteurisation procedures and cooking procedures for egg products are shown in Table 1.3.

Table 1.3 Current pasteurisation and cooking procedures for egg products

Egg product	Retention temperature to be no less than (°C)	Retention time to be no less than (minutes)	Maximum temperature to be immediately rapidly cooled to (°C)
Egg pulp	64	2.5	≤ 7
Liquid egg yolk	60	3.5	≤ 7
Liquid egg white	55	9.5	≤ 7

Note: This table is contained in clause 21 of the *FSANZ Draft Assessment Report 1 on Proposal P301*, which includes a draft variation to the Australia New Zealand Food Standards Code (FSANZ 2009).

These conditions are not sufficient to inactivate most ND virus strains, some of which require up to five minutes at 67°C, up to 30 minutes at 58–64°C, and considerably longer times at 55°C (Arzey 1989, Biosecurity Australia 2008).

Fertile eggs

ND virus has been isolated from eggs laid by infected breeding hens (Williams and Dillard 1968). Capua et al (1993) isolated virulent ND virus from fertile eggs and live progeny of vaccinated breeders. Transmission by this route remains controversial, with its significance for spread of infection in outbreaks unclear (Alexander 1997). However, it has been noted that ND virus is shed in large amounts in the faeces of infected hens and infected and contaminated eggs can be expected to be laid (Beard and Hanson 1984, Alexander 1997); these authors also noted that it would be unlikely that a live chicken would hatch from an egg internally infected with virulent virus. Fumigation and/or sanitisation of eggs and strict hatchery hygiene should be ensured during an outbreak.

Poultry byproducts

Rendered meals, produced from frames (boned-out skeletons), viscera, blood, feathers, feet, heads, necks, offcuts, birds dead in trucks and discarded live birds, are added to poultry feed as poultry offal meal and tallow. They may also be added to pet foods.

Poultry offal meal and pet foods are usually cooked at above 100°C for from several minutes to more than one hour, which is sufficient to kill ND virus. However, if the procedure is not carried out properly or cooked product is subsequently contaminated by unprocessed product, ND virus could persist for several weeks. There should be strict supervision of trucks that collect waste products to ensure that they are not used for transporting rendered products without being thoroughly cleaned and disinfected.

Waste products

Waste can be any of the unwanted byproducts of processing. All products that go into the production of rendered meals may also be discarded as waste. In addition, there will be wastes from hatcheries, laboratories (autoclaved cultures and specimens, dead birds), farms, egg marketing establishments (unsaleable eggs, egg shells after pulping, soiled egg fillers), as well as chicken manure and litter.

In the poultry house, ND virus has been shown to survive on feathers for 255 days and in litter for 42 to 53 days. Most of the waste is normally collected by industrial waste companies or burned/buried/composted on the site. ND virus has the potential to persist in these products and could be disseminated by vehicles that transport them unless surface disinfection is carried out.

ND virus can remain viable in poultry faeces, which will readily contaminate people and fomites. Spread of the disease has been associated with the use of chicken manure as fertiliser (Kelly 1973). In the 1990s, Dutch authorities banned the disposal of litter by distribution on land within 500 metres of commercial poultry premises.

Fomites

Survival times of various ND virus strains in soil and litter, and on hessian bags and feathers, demonstrate the ability of the virus to withstand adverse environmental conditions and the capacity of these materials to act as vehicles for

spread of the virus. Survival times are dependent on environmental temperatures and relative humidity.

Movement of people and equipment

Secondary spread in epizootics in recent times has been explained largely as a result of the movement of live birds or personnel and equipment, with transfer of infected faeces on hair, clothing, footwear, crates, feed sacks, egg trays, vehicles or other equipment (Alexander 2000).

1.6.3 Modes of transmission

Dissemination of virulent ND virus between flocks has been attributed to the following (in descending importance):

- movement of infected birds (including vaccinated birds);
- movement of feedstuffs, personnel and equipment into and out of premises;
- movement of infected poultry products and byproducts; and
- faecal virus contamination of clothing/footwear, equipment, litter, manure and feed (Utterbuck 1972; Alexander 1988, 1997, 2000).

Spread of infection within flocks in the New South Wales outbreaks of 1998–2000 was more rapid with birds on litter than with birds in cages.

Live birds

- The movement of infected and contaminated live birds is the single most important means of spreading ND.
- Within a flock, the main method of transmission is by inhalation of virus-laden expired air or by ingestion of drinking water or feed contaminated with nasal secretions or faeces containing virus. Coughing is not necessary to produce infective aerosols, which are distributed by normal air turbulence in poultry sheds.
- Air sampling in hen houses during outbreaks showed high levels of virus in houses, detectable levels 64 metres away at night, and undetectable virus at 165 metres from infected flocks. During the day the survival of virus in aerosols was optimal at relative humidity 70–80%. The levels recorded in the hen houses were very much lower than virus levels recorded in animal houses with foot-and-mouth disease, and vaccination very markedly reduced excretion of virulent virus (Hugh-Jones et al 1973). The aerosol spread of virulent ND over considerable distances has not been established as a significant method of spread in epizootics (Alexander 2000).
- Day-old chickens transported in contaminated carrier boxes caused significant spread of infection in California in 1972 (Utterbuck and Schwartz 1973).
- Trade in backyard and fancier poultry was implicated as a significant source of infection spread in the European Union from 1991 to 1994.

- Transmission of ND virus by wild birds can occur from endemic foci among wild birds to poultry (unusually), or mechanically from an infected poultry premises to susceptible poultry.
- Wild waterfowl are believed to be refractory to ND but can become carriers and shed virus over a long period.
- Transmission of ND virus from aquatic birds to nonaquatic birds has not been investigated; migratory birds are believed to have spread virulent ND virus infection in Europe in the 1990s (Alexander 2000).
- Pigeons can spread ND virus by contaminating poultry feed. Close interactions between feral pigeons and racing pigeons in urban and rural environments favoured the spread of pigeon-strain virulent ND. Cage and aviary birds could become infected by contact with infected pigeons.

Inapparent carriers

- Virus can remain latent in the trachea and has been recovered by organ culture from the trachea of one bird 120 days after infection (Heuschele and Easterday 1970). Latent ND virus in vaccinated or nonvaccinated birds may be shed by:
 - birds that shed virus spontaneously and intermittently;
 - birds subjected to stresses, such as transport or intercurrent disease; and
 - carrier birds whose carcasses are fed to other animals in which digestive enzymes release virus from antigen-antibody complexes.
- Virulent ND virus has been detected in infected vaccinated flocks for more than four months (Krauss 1965, Utterbuck and Schwartz 1973).
- Ducks and geese can be reservoirs of virus and ND outbreaks have occurred where a virulent virus, which did not cause clinical signs in infected geese and ducks, was transmitted to domestic poultry (Beard and Hanson 1984).
- Pools of highly virulent ND virus are thought to occur in psittacines and passerines in countries endemically infected with ND.
- Captive caged birds have frequently been proven to be infected with virulent ND viruses and outbreaks have established in commercial and backyard poultry from such sources; infection has been demonstrated in psittacines for more than a year (Alexander 2000).
- ND virus has been recovered from over 25% of introduced pet birds quarantined in the United States. Some of these species can become carriers and some parrots have excreted virus for more than a year. Australian species may need to be considered as potential risks during an outbreak here (Bains 1993, Gilchrist 1993).
- Canaries have been reported not to become carriers (Senne et al 1983).

Poultry products and byproducts

- ND virus can be transmitted by insufficiently treated poultry meat products, table eggs and egg pulp products (see Section 1.6.2). However, the significance

of transmission by these routes in outbreaks has diminished from the 1960s to the 1990s (Alexander 2000).

- While pelleting of feed at 80–90°C for 30 seconds is not expected to completely inactivate ND virus, pelleted feed has not been implicated in outbreaks unless contaminated after treatment, such as with infected faeces from pigeons as occurred in the European outbreaks in the 1970s and 1980s.

Fertile eggs (vertical transmission)

- Vertical transmission through eggs has been demonstrated and ND virus has been isolated from eggs laid by infected hens. It remains controversial whether embryos infected with virulent ND viruses would survive to hatching. ND virus may, however, survive the egg incubation process and be present on the outside of the shell. This is not thought to be an important method of spread (Alexander 2000). Capua et al (1993) described the isolation of virulent ND virus from embryonated chicken eggs.
- An experiment in Australia demonstrated that no virulent ND virus was isolated on or in eggs laid by twice-vaccinated hens (HA Westbury, AAHL, pers comm, 2000). A similar experiment with once-vaccinated layers demonstrated Herts 33 virus in one egg and in cloacal swabs of many chickens but no Texas GB virus in cloacal swabs or eggs after challenge (P Daniels, AAHL, pers comm, 2003)
- Fumigation of eggs together with strict hatchery hygiene has been suggested as a means of salvaging genetic stock from uninfected eggs in an unvaccinated infected flock but, if this is contemplated, strict protocols will be needed along with quarantine and intensive monitoring of flocks hatched from these eggs.

Fomite spread

- Spread on fomites during movements by humans is the second most important method for spreading virulent ND in outbreaks.
- ND virus can be spread by contaminated clothing/footwear and equipment such as crates and egg fillers, containers, vaccinating and beak trimming equipment, vehicles and meat chicken catching equipment.
- Feathers are known to harbour virus for long periods and these could provide an opportunity to disseminate infection on wind if not controlled on infected premises by disinfection.
- Rapid transport methods employed in modern industry are capable of moving contaminated materials over long distances, often interstate, in a few hours.

Windborne spread

- In the 1960s and 1970s, claims of widespread airborne transfer of infection by aerosol were made in the United Kingdom. However, aerosol spread was not considered important in the ND virus in outbreaks in Nigeria and the southern and western (California) United States summarised by Lancaster and Alexander (1975), or in the outbreaks in the United Kingdom and Europe in the 1980s and 1990s (Alexander 2000). Other, more likely explanations for such

spread of infection in more recent outbreaks include movement of birds, humans and equipment (Alexander 2000).

- Windborne transmission by infected feathers and other debris in litter and faeces during cleanup operations probably played a part in local spread in the Californian outbreaks, and for this reason Dutch authorities in the 1990s imposed bans on the disposal of litter by distribution on fields within 500 metres of poultry sheds.
- In Australia, windborne spread by contaminated feathers, dander and other debris in litter has to be seriously considered as a source of virus. For comment on the aerosols produced during infection, see *Live birds*, above.

Vector spread

Any animals, including flying insects, that travel between infected and susceptible birds can spread the virus by mechanical means, although this means of transmission is a low priority. In the United States, flies have been reported as being able to spread ND virus for up to 10 days and a distance of kilometres.

1.6.4 Factors influencing transmission

As noted above, the principal means by which virulent ND virus spreads in outbreaks is by the movement of live birds, contaminated feed, equipment, materials and personnel, and windborne transmission of contaminated materials from infected birds and from the spreading of litter.

In laboratory studies comparing exotic and Australian-origin ND viruses, it has been shown that the Australian viruses have comparable lethality to exotic ND viruses (Herts 33 and Texas GB) by parenteral inoculation (intracerebral and intravenous) but not all Australian-origin viruses are as lethal or as transmissible following ocular, oral and nasal inoculation. Following the natural routes of infection and transmission by direct contact with other birds, all birds infected with the exotic ND groups were dead by 11 days, whereas most birds infected with Australian-origin group viruses were alive at 10 to 15 days (P Selleck, AAHL, pers comm, 2003).

The production of virus and transmission of ND will be influenced by the immune status of a flock. Some Australian flocks have become partially immune after natural exposure to nonpathogenic strains of ND virus (Spradbrow et al 1980); such flocks can maintain virulent ND virus infection. There is the possibility of virulent ND viruses arising by mutation from such strains as the Peats Ridge family of viruses (as occurred in the New South Wales outbreaks of 1998–2002). In immune and partially immune flocks, exotic ND could remain undetected while the virus is being excreted by symptomless infected birds and while few deaths are occurring. This raises the possibility of exotic ND virus spreading undetected in Australia for a period before causing a sudden, explosive and widespread epidemic in unprotected flocks. Widespread, indiscriminate vaccination could also exacerbate this problem. This situation of widespread infection did not arise in 1999–2000 in Australia, as evidenced by the national survey of ND viruses in the

latter half of 2000 (National Newcastle Disease Virus Survey 2000, unpublished),⁸ which demonstrated only the isolation of V4-like viruses and no isolation of pathogenic ND viruses. Peats Ridge or other precursor viruses were not isolated on any vaccinated properties, although Peats Ridge virus was isolated on four properties where vaccination had not been used.

Some strains of ND virus spread more readily than others. Australian lentogenic strains have been shown to spread readily in Australia, especially in production systems on litter. Ability to spread rapidly within a shed is a useful characteristic for a vaccine strain but an outbreak caused by a rapidly spreading virulent strain would pose considerable eradication problems due to lack of clear evidence of virulent disease.

The part that would be played by free-flying birds in the dissemination of virus from an infected farm is unclear, and while many farms adequately exclude such vectors, some still do not. Free-range farms could potentially become infected following contact with infected wild birds.

The viability of ND virus in the atmosphere is enhanced by low temperatures, high humidity and short day length, although lentogenic strains occur widely in meat chicken flocks in southeast Queensland, an area which rarely has this type of weather. The virus may not survive well in the hot and dry climate of the southern parts of Australia in summer, although this was the time when it spread very efficiently in southern California in 1972. Spread in California in 1972 was largely through the movement of infected birds and the movements of people with contaminated clothing and equipment.

Some of the major poultry farming areas in Australia are closely settled and contain large numbers of birds (three million on one site near Sydney). Areas of high population density will make possible the rapid transmission of the virus to large numbers of other birds. To overcome this danger, some important breeding flocks have been duplicated and moved to locations remote from other flocks.

1.7 Manner and risk of introduction to Australia

Virulent exotic ND virus might enter Australia in a number of ways. The most probable means is by smuggling of birds, particularly pigeons and parrots (which have the potential to be nonclinical carriers), because the absence of an avenue for legal importation produces considerable pressure for smuggling.

A second course is for the disease to spread from Indonesia into Papua New Guinea and then on to Australia. This is regarded as unlikely, given the controlled movement of people and birds in the Torres Strait quarantine zone and the distance from commercial poultry centres.

A third potential route is through migratory wild birds, although this has not occurred despite three major epizootics over the past 50 years (1948–83).

⁸ Reported in: Rural Industries Research and Development Corporation (RIRDC), Annual Report 2000–01, Sections 3.1 (Chicken meat) and 3.2 (Eggs)

There is also the potential for contaminated refuse from illegally introduced poultry meat being fed to poultry. Refuse from international transport is considered to be a low-risk source, as swill feeding to commercial poultry is practically nonexistent and maritime and airport wastes are disposed of securely (Geering 1990).

1.8 Social and economic effects

The gross value of production of the Australian egg industry is approximately \$413 million and that of the chicken meat industry is \$1.86 billion (ABS 2010⁹). In an ND outbreak, the main losses are due to bird mortalities, which can be high, and decreased egg and meat production on infected premises. There will be further loss of income for an extended period due to the stamping-out policy. Disruption of the flow of product and decreased production may cause job losses on farms, and in service and associated industries, depending on the time it takes to bring the outbreak under control. Even a small outbreak will result in dislocation of the industry and its normal marketing patterns. An uncontrolled outbreak will markedly increase production costs through the impact of the disease and the need for ongoing control measures.

Infection in grandparent and foundation flocks may cause the loss of some valuable genetic material.

The presence of the disease is likely to result in all poultry exports ceasing in the short term with, perhaps, a recommencement of exports from disease-free areas after a period of review by, and negotiations with, trading partners.

The control measures will result in disruption to breeding and production programs, and the supply and movement of birds and products to producers, processors and the public. Decision makers should constantly review movement controls and restrictions to reduce the effects on production and marketing systems wherever possible. This can be achieved under the arrangements for industry-government consultation throughout an outbreak.

Other enterprises, such as pet shops and exotic bird traders, will also be affected by the control measures adopted.

1.9 Criteria for proof of freedom

The OIE Terrestrial Code for ND states that a country, zone or compartment may be considered free from ND when it has been shown that ND virus infection in poultry has not been present for the past 12 months, based on surveillance in accordance with Articles 10.9.22. to 10.9.26. If infection has occurred in poultry in a previously free country, zone or compartment, ND free status can be regained three months after a stamping out policy (including disinfection of all affected

⁹ ABS (2010): Report 7501.0 - Value of Principal Agricultural Commodities Produced, Australia, Preliminary, 2008-09 (accessed 12 May 2010)

establishments) is applied, providing that surveillance in accordance with Articles 10.9.22 to 10.9.26 has been carried out during that three-month period.

In Australia, vaccination is likely only to be an adjunct to the stamping-out policy, and used in association with other control measures. However, widespread infection with a progenitor virus that gives rise to virulent ND virus might encourage the use of vaccination in designated areas to ensure that eradication, with or without stamping out, will be successful.

Proof of freedom from ND can best be achieved by clinical observations and dead-bird sampling of repopulated sheds and possible disease outbreaks, rather than by widespread biological testing.

Some serological surveillance will be required and it is recommended that this be performed on former infected premises, dangerous contact premises, trace premises and suspect premises at 30 days and at five months after restocking, in order to satisfy a 95% confidence of detecting infection at less than 5% prevalence. This would be supported on these premises by twice-weekly clinical examinations for 30 days and then fortnightly for five months. Virus isolation would be carried out on a sample of dead birds. Seropositive flocks will require further investigation and virus isolation attempts. Some ancillary surveillance would need to be undertaken in the former restricted area and control area to demonstrate freedom from the agent; this surveillance needs to concentrate on the commercial poultry industry.

Further testing may be considered in other areas if the epidemiological information suggests that this is warranted.

See Appendix 1 for further details on proof of freedom.

2 Principles of control and eradication

2.1 Critical factors assessed in formulating response policy

Newcastle disease (ND) viruses cause a wide range of clinical conditions in domestic poultry, cage and aviary birds and wild birds. Many of the clinical syndromes mimic those seen in other conditions and, in particular, may be indistinguishable from avian influenza.

ND virus is stable under a wide range of environmental conditions, allowing it to be spread very easily from flock to flock directly by movement of infected birds, by windborne spread in densely populated areas, by faecal contamination of personnel and equipment moving between properties, and in processed poultry feed.

The basis for the eradication of exotic strains of virulent ND virus in Australia has been the rapid imposition of effective quarantine on all birds on which any degree of suspicion falls, the elimination by stamping out of the pathogen where it is known to have been present, disinfection of premises, and controls on the movement of known and suspected contaminated personnel, materials and fomites. Key factors in achieving these objectives are rapid reporting and diagnosis, swift imposition of effective movement controls, and tracing of infected birds and contaminated humans, materials and equipment.

The occurrence of Australian-origin and precursor viruses in a significant part of the poultry population in Australia requires the adoption of more broad-ranging control strategies than would be applied to outbreaks of exotic ND, which would be expected to occur in a more limited area. To prevent the emergence of Australian-origin ND viruses and limit outbreaks, the major control strategy is solid vaccination of flocks across those areas where the precursor and Australian-origin ND viruses occur. The Australian-origin ND viruses produce less dramatic disease and have lower transmissibility than classical exotic ND viruses; there may be more scope to use new strategies for handling suspect and infected flocks than would apply during exotic ND outbreaks.

The OIE Terrestrial Code states that trade measures related to ND apply only to infection in poultry (as defined by the OIE).¹⁰ Notification requirements in the Code chapter on ND are ill-defined for birds other than poultry. The decision to notify the OIE of an outbreak of ND in birds other than poultry will be made by the Consultative Committee on Emergency Animal Diseases (CCEAD) on a case-by-case basis.

¹⁰ i.e. domesticated poultry, used for the production of meat or eggs for consumption, or other commercial products - birds that are kept in captivity for any other reason, including those that are kept for shows, races, exhibitions, competitions, or for breeding or selling these categories of birds as well as pet birds, are not considered to be poultry.

2.2 Methods to prevent spread and eliminate pathogens

The present policy for incursions of exotic pathogenic ND viruses is to eradicate the disease as soon as it is confirmed, by the immediate isolation of infected birds followed as rapidly as possible by slaughter and sanitary disposal of carcasses. Other animals or birds that could transmit the disease must be controlled or destroyed and infected sites thoroughly cleaned and decontaminated. Movements of infected birds and contaminated humans, materials and equipment must also be followed up.

It remains Australian policy to eradicate virulent (velogenic and mesogenic) ND viruses that may arise endemically, by means of slaughter and disposal of infected birds. If an ND outbreak is shown to be widespread or progenitor viruses are shown to be widespread, the policy is to zone an infected area and vaccinate all flocks within it if infection is not quickly contained.

2.2.1 Quarantine and movement controls

Experience has shown that ND can spread very rapidly and can be carried over long distances by transport of contaminated materials (such as bird cages, pallets, egg filler flats, manure, feed and other equipment), as well as by contaminated personnel. Because ND is very readily transmitted via fomites, strict control over the movement of anything that could have become contaminated with virus, by the immediate imposition of tightly controlled quarantine on all places suspected of being infected, is essential to a successful eradication program.

Quarantine should be imposed on all farms on which infection is either known or suspected and should be strictly policed to ensure that no-one, including the owners, their friends and staff, leaves without showering and changing clothes and footwear. Service vehicles on the premises at the time quarantine is imposed must be disinfected as they leave the premises.

Although the evidence is largely circumstantial, free-flying birds are believed to have been vectors in some outbreaks overseas. The commercial poultry industry needs to operate biosecurity systems that prevent contact with wild birds. There is a need to consider the removal or vaccination of potentially infected backyard flocks of commercial poultry species.

Infected premises, dangerous contact premises and suspect premises

Quarantine of infected premises (IPs) prevents the spread of the disease by prohibiting the movement of birds, products and materials to or from the property. These movements, together with the movement of humans, are the main methods for spreading ND. It is important to apply quarantine measures as early as possible to slow the rate of spread in an area. Detailed tracings of the movement of birds, feedstuff, poultry products and wastes to and from IPs and dangerous contact premises (DCPs) are a high priority from the very beginning of an outbreak of ND.

Quarantine measures should be applied immediately, even where there is doubt about infection. Such action may result in protests but must be taken pending a full investigation and understanding of the epidemiological situation. It may well take several weeks before there can be any confidence that other properties in the area are not incubating the disease and, during this period, the strictest quarantine measures must be maintained. If possible, DCPs should be slaughtered out before

the flocks excrete virulent virus. Effective quarantine of premises will require security to be maintained around the clock to ensure that only authorised personnel, in protective clothing, are allowed to enter. It will be necessary to limit and supervise the movements of residents onto and off the property and to ensure that all pets are confined.

It is also important to attempt to establish the critical date of the outbreak: that is, when the infection was initiated. The incubation period for ND is 15 days, but this should be extended to 21 days to cover the possibility that the first cases were not recognised, and to be consistent with the OIE Terrestrial Code. All movements that took place during the previous 21 days should be traced back (see Section 2.2.2).

Restricted areas and control areas

The declaration of a restricted area (RA), which should include the IPs and as many of the DCPs and SPs as possible, helps prevent spread by restricting movements on and off premises that have had direct or indirect contact with infection. However, movement controls in the RA should not hinder the movements of members of the general public who are not associated with poultry.

The RA can have an irregular perimeter, provided the initial boundary is an appropriate distance from the nearest IP, DCP or SP. This will vary with the size and nature of the potential source of virus, but will usually be about 1–5 km from such premises. The boundary will be fixed taking into account the distribution of susceptible birds, as well as traffic patterns to markets, service areas and abattoirs, and areas that constitute barriers to movement.

The declaration of a control area (CA) surrounding the RA helps to limit the spread of the outbreak from within the RA. The CA is a buffer zone between the RA and the rest of the industry and country. The CA boundary does not have to be circular or parallel to the RA boundary, but should normally be 2–10 km beyond it.

Movement of possibly infected birds and contaminated things and materials *within* the CA will be allowed, but movement out of the CA will be prohibited without chief veterinary officer (CVO) or delegated approval. As far as possible, normal commerce should be allowed to continue. Processing poultry from the CA inside the CA would be ideal.

If the RA or CA contains an appropriate place for poultry slaughter, consideration can be given to permitting removal of spent hens and meat birds of suitable size from SPs (where no sign of infection has developed during the declared incubation period) for supervised slaughter for human consumption under standard operating procedures (SOPs). This should also be permitted for flocks under vaccination, particularly if they are being monitored, and if the processing plant also maintains SOPs to minimise further spread of ND infection. This reduces the risk of infected birds being removed; the risk is further reduced by the cooking processes involved in the human food chain. If properly managed, this risk can be preferable to the virus production that would result from the development of clinical disease.

Zoning

Understandable pressure to impose interstate (and possibly even intrastate) movement controls on poultry products may be expected. However, it is desirable

to minimise such controls because they cause a large part of the economic loss suffered by the rest of the industry during an exotic disease outbreak. It is very probable that interstate commerce involving poultry products from outside the RA could be carried on with no real danger of disease transmission. Whether this is acceptable to trading partners is for them to decide.

An outbreak may occur in an area that is not easily controlled or in an area that crosses a state/territory border. This could more rationally be handled by declaring a defined zone(s) rather than the state border as the operational boundary. Such an arrangement would need to be endorsed by the CCEAD (see Section 3.1) and be consistent with the OIE Terrestrial Code chapter on zoning and compartmentalisation (Chapter 4.3).¹¹

2.2.2 Tracing

The information obtained from tracing and surveillance will help to decide the extent of the RA and CA and identify any additional DCPs and SPs. Trace-back and surveillance information should be gathered on Animal Health Emergency Information System (ANEMIS) forms.

- The critical date is determined as the earliest time the virus could have entered the IP and should be consistent with the maximum incubation period, designated by the OIE, of 21 days.
- Movements to and from IPs and DCPs for at least 21 days before the first observation of unusual morbidity or mortality should be traced as a foremost priority.
- Movements of birds, eggs, poultry products, feed, litter, waste and equipment should be traced to make sure that they are disposed of or decontaminated with minimal risk to the commercial poultry industry.
- People involved with feed delivery, vaccinating crews, catching crews, tradespeople, company service representatives and veterinarians should be interviewed and lists compiled of all their possible contacts for the three days following a visit to any premises under suspicion.
- The original source of introduction of the virus should be traced, as it could remain a threat.

2.2.3 Surveillance

Active surveillance should be initiated as soon as ND is confirmed. In the initial stages, at least, samples should be taken of all species of birds that die in the RA and they should be checked for ND lesions; specimens should be submitted to approved laboratories for virus isolation.

¹¹ www.oie.int/index.php?id=169&L=0&htmfile=chapitre_1.4.3.htm

Surveillance also needs to be carried out on vaccinated flocks in the RA and CA. Field surveillance should seek to detect changes in flock health. Examinations need to be at least twice weekly by:

- producers carrying out their own surveillance, and reporting by telephone; and
- local disease control centre officers carrying out regular telephone surveillance of independent premises.

All reports of a decline in health status should be investigated further. Recommended surveillance procedures are described in Appendix 1.

Although surveillance will begin immediately on and around the IP or infected flock, it will have to be extended very quickly to all other sites where there has been movement of contaminated birds, products and materials from the IP (see Section 2.2.2). Information obtained from active surveillance will help to decide the extent of the RA and CA and identify the DCPs and SPs.

Surveillance of wild birds to determine their potential involvement in the dissemination of the disease may be necessary (see the **Wild Animal Response Strategy**). The OIE proposal to allow 'compartmentalisation' (see Section 2.2.1, Zoning) will reduce the need to investigate and/or contain virulent infection in wild bird populations unless there is evidence for their involvement.

2.2.4 Treatment of infected birds

Treatment of birds with ND is ineffective and not appropriate.

2.2.5 Destruction of birds

Efficient, humane procedures must be used to kill birds before disposal, without moving them from the site.

Individual birds, such as pet birds or those in aviaries, are relatively easily destroyed by dislocation of the neck.

Several gases have been used to kill large numbers of birds: cyanide, methyl bromide, carbon dioxide, exhaust gas and nitrogen. Of these, carbon dioxide and nitrogen would be preferred for large populations of birds because of their relative lack of toxicity to humans. Whether to gas caged commercial birds in their cages depends on the nature of the buildings, the size and number of birds per cage and the timespan before they are to be removed. It can be extremely difficult to remove dead birds from cages once rigor mortis is established. It may be better to remove birds from their cages alive and gas them in an enclosed trailer or container.

Dispersal of virus by airborne infection should be prevented by closing up sheds during depopulation. Disinfection of the litter surface, and containment of feathers and other material, can reduce the load of virus that can potentially be spread. Access of wild birds to commercial poultry sheds and flocks should also be taken into account when deciding on the order in which to start depopulation operations.

For floor-raised chickens housed in sheds, destruction with wet foam may also be an option. This method is not to be used in multilayer sheds or with ducks.

For further details, see the **Destruction of Animals Manual**.

2.2.6 Treatment of poultry products and byproducts

See Section 1.6.2 for information on cooked products, Section 2.2.7 for information on disposal of infected products and byproducts and Section 4 for details of movement controls.

2.2.7 Disposal

One of the major objectives of the eradication program is prompt and effective disposal of infective material in which virus could persist, for example fresh and frozen carcasses, dead birds, eggs, litter, manure, waste products, fittings and building materials that cannot be effectively decontaminated. Available methods include burial, incineration, burning, rendering and composting. The removal of very large numbers of birds in a short time presents environmental and logistical problems. An average shed of meat chickens close to market weight represents about 40 tonnes of organic material, of which 75% is water (see the **Disposal Manual**).

Litter can also pose special problems because infective virus on the surface of dry litter may cause airborne spread when the litter is removed for disposal. It will be necessary to moisten the surface with a disinfectant/detergent and possibly heap it in mounds, under plastic, before removal for burial or horticultural purposes (see the **Decontamination Manual**).

If infected material must be transported elsewhere for disposal, particular attention should be paid to eliminating factors that will contribute to spread of the virus. For example, truck body trays must be waterproof and all loads carefully covered with tarpaulins to ensure that material cannot be blown about (for detailed information see the **Disposal Manual**). Minimising the distance of transportation of infected material is desirable.

Burial

Burial is the best, and perhaps the cheapest, option if it can be achieved at the infected site itself but is becoming a less attractive option with environmental authorities. It is important to minimise the distance of transportation of infected material but burial at the site may not be possible because of a lack of a suitable burial site (as outlined in the **Disposal Manual**); arrangements may have to be made for burial elsewhere, taking into account commercial poultry in that area. Where a number of infected foci have to be depopulated, a common burial site outside the infected premises may be a more efficient option.

Incineration/burning

Incineration is an effective and safe means of disposal, but incinerators are usually too small or too far away to be of practical use.

Burning (eg in pits or on pyres) has been used where no burial sites are available. However, because of the high water content of the carcase, it is an expensive method; it may also be environmentally unacceptable.

Rendering

Rendering is a good means of disposal if the rendering plant has the capacity needed and if it is possible to safely and effectively decontaminate the plant afterwards. Private rendering plants may not be willing to handle infected birds and eggs. Infected material would need to be transported from infected sites to the plant, although transportable rendering plants may be practicable.

Composting

Composting on site is a practical means for handling large quantities of manure, litter and carcasses. Composting off site may be permitted if it can be ensured that there will be no dissemination of infection during transport and handling.

Disposal at abattoirs

Abattoir disposal is an option in certain circumstances, subject to approval by CCEAD on advice from the CVO of the state or territory involved in the response.

2.2.8 Decontamination

Decontamination entails *cleaning* and *disinfection* of the infected site to remove all infective material. ND virus is susceptible to a wide range of disinfectants, including detergents. Initial cleaning of organic matter from sheds, equipment, vehicles and so on by brushing and washing with a detergent is the most important step before disinfection.

The quantity of disinfectant to be used in an outbreak will usually be several times more than that used in routine disinfection procedures. Particular attention should be paid to the decontamination of litter. As the ND virus can survive up to 53 days in litter material and 255 days on feathers, it is necessary to quickly disinfect the surface of the litter and adopt measures such as composting for thermal inactivation of the virus to take place. Because most disinfectants are inactivated by organic material, contaminated litter may have to be buried or burned after surface disinfection if temperatures are not elevated above 55°C in the composting process.

Following initial cleaning and disinfection of surfaces, it is practical to allow time for the completion of the decontamination process. The high daily temperatures and low humidity of the Australian summer can be relied on to inactivate infectious agents; in the 1998 ND outbreak, an IP was left for six months to decontaminate after a high-pressure wash-down.

Equipment and fixtures should be dismantled, hand-washed and disinfected rather than cleaned and disinfected in situ by use of high-pressure water or steam hoses, unless they can then be left for six months. Fomites, such as clothing, footwear, crates, feed sacks and egg fillers, should also be disinfected, if possible, or destroyed.

Sheds, yards, rendering plants, their surroundings and burial and burning grounds should be decontaminated as soon as possible.

For further information see the **Decontamination Manual**.

2.2.9 Vaccination

The fundamental method by which eradication may be achieved is the immediate isolation and destruction of infected birds, followed as quickly as possible by slaughter and sanitary disposal of carcasses.

However, under some circumstances, it will also be necessary to use vaccination with or without slaughter of birds. The epidemiological considerations that could apply over a vast range of possible outbreak scenarios mean that decisions on vaccine use will need to be based on the circumstances prevailing at the time.

Vaccination can be applied to levels where birds become virtually refractory to infection with virulent ND viruses. The measure of the immunity of a bird to infection is reflected in the titre of antibody and the resistance of local mucous membranes to infection. The application of effective vaccination programs, together with other biosecurity measures, across an area where ND viruses have become endemic has led to the eradication of exotic ND viruses in other countries.

Vaccination could be used as part of an eradication/control campaign to meet one of three sets of strategic objectives:

- reduction of virus production in large populations of poultry for which slaughter is delayed by shortage of resources, and/or
- provision of a barrier of immune birds to assist in area containment, and/or
- protection of particularly valuable or genetically important populations of birds;

or

- compulsory vaccination in a defined area together with movement restrictions to prevent virulent virus transmission over a period of time to enable elimination of the virulent virus and any precursor strains;

or

- removal of movement restrictions and allowing voluntary vaccination, if it is decided that Australia should live with virulent ND because of an inability to control the disease.

In choosing to use vaccination *with* or *without* slaughter of known infected flocks (stamping out), the issue to be considered is the time period required, according to the OIE rules, before ND-free status can be obtained for an affected country, zone or compartment. If stamping out and disinfection are carried out, whether or not vaccination is used, this time period is three months from the last occurrence of infection in poultry, provided that appropriate surveillance is carried out.

The use of vaccine does not address the likelihood of Australian-origin and precursor ND viruses continuing to exist in endemic areas, and of further outbreaks. Vaccination should be avoided if it is believed that stamping out an infected premises is highly likely to eliminate the virulent virus from a recent focus of infection.

It is the aim of Australia to maintain a stamping-out policy for as long as possible. If an outbreak begins in a very large poultry farm and is known to have extended rapidly to other premises in an area of very dense poultry population, it may quickly become apparent that available resources are insufficient to prevent further

rapid spread using only slaughter and disposal methods. In such a case, using vaccine to reduce virus production in infected flocks or to provide a barrier of immune birds by vaccinating in a ring around the restricted area would need to be considered. Slaughter out could progress in line with industry practice if undertaken using strict SOPs that include high-level biosecurity practices.

If the aim is to establish a ring of vaccinated flocks, the outer edge of the ring should be put in place first, in case the virus has already spread further than expected. If the aim is to protect valuable flocks, then these should be vaccinated first. Vaccinating flocks from the perimeter to the centre of a zone will allow vaccination teams to move from low-risk to high-risk flocks, thereby reducing the chance of inadvertently spreading the virulent virus (as happened in California in 1972). Farmers should carry out vaccinations wherever possible.

However, if an outbreak begins in an area where bird density is low, even though on a very large farm, it would probably be practicable and more desirable to prevent spread and eradicate the disease using only quarantine and slaughter.

If vaccination is to become part of an eradication strategy, it will need to be subject to the following conditions:

- The decision to use vaccine will rest with the CVO of the affected state/territory and CCEAD, in consultation with industry.
- Decisions about which flocks to vaccinate, and when, will be made by the CVO of the affected state in the context of the national strategy plan.
- CVOs in unaffected states may need to permit the entry of vaccinated replacement pullets and allow vaccination of pullets that are to enter affected areas, in the interests of the national poultry industry.
- The CVO, subject to conditions regarding seed lot, substrate and vaccine batch testing, will encourage Australian manufacturers to immediately redirect vaccine destined for overseas markets to the local market and/or increase vaccine production.

Research has demonstrated that V4 strain vaccine is nonpathogenic and immunogenic, giving protection to half the vaccinated chickens as early as seven days after aerosol application. Vaccination may mask clinical disease, and surveillance methods to detect subclinically infected flocks need to take this into account.

Breeding stock

If vaccination of genetically important 'foundation' stock is permitted, a protocol agreed by CCEAD needs to be established for the safe removal of eggs from the farm for hatching. The fate of the flock will depend upon whether or not it subsequently becomes infected. It is possible for eggs from infected birds to be infected, but such eggs are likely to suffer early embryonic death and may be removed from the incubator on candling. It is also possible to sanitise the surface of eggs to reduce the transfer of ND virus during the hatching period.

If a vaccinated infected flock is shedding virulent virus under the eradication strategy, the flock will be destroyed and disposed of immediately. If the vaccinated

flock remains uninfected and does not shed ND virus, the protocol should specify the conditions under which eggs could be removed for hatching.

Basically, the protocol will stipulate the quarantine measures that would be imposed on the farm, hatchery and brooder/growing house; the procedures for the collection and sanitising of eggs; and the procedures to be adopted for the detection of virus or disease at the hatchery and the brooder/growing house (see the **Poultry Enterprise Manual, Section 4**).

To gain the greatest benefit from vaccine protection of genetically important stock, it is best to vaccinate as soon as possible after the beginning of an outbreak. This requires that all flocks to be so protected have been identified by the industry and placed on an agreed list.

2.2.10 Wild bird and pest control

In five virulent avian influenza outbreaks and numerous virulent ND outbreaks in 1930, 1932 and 1998–2000 in Australia, wild birds were not proved to be infected. Wild birds that visit poultry sheds may harbour and shed ND virus or spread the virus mechanically. Overseas, they have been implicated as the initial cause of exotic ND outbreaks. However, wild birds appear to play little part in the spread of disease between flocks during an outbreak. The proposed OIE compartmentalisation of bird populations in countries and zones into domestic and free-living birds (see Section 2.2.1) will enable wild birds to be treated in perspective unless clinical disease or infection is established; even if the virus is established in free-living birds, the infection status of commercial poultry would not be affected until infection occurred in that compartment.

To minimise the risk from wild birds, it is essential to practise high-level biosecurity. Birdproofing of quarantined and other poultry houses and protection of contaminated sites from birds during eradication procedures are essential disease control strategies and need to be rigorously enforced. The control and destruction of rats and mice is also important because they can act as mechanical carriers. For further information, see the **Wild Animal Response Strategy**.

Other birds

After notification of a suspected outbreak, it may be necessary to ban pigeon racing activities, bird shows, local sales and markets in the RA and CA. Racing pigeons have been a source of virus in other countries. However, the outbreaks associated with pigeons were of a particular strain that gained entry to commercial poultry through the contamination of prepared poultry feeds by feral pigeons.

Particular attention must be paid to workers on IPs who keep poultry at home. It is advisable to destroy or vaccinate such birds as soon as possible, even though they may be ornamental or pets. Pet birds linked to DCPs and SPs should be quarantined and kept under surveillance with or without vaccination.

2.2.11 Vector control

The control of vermin should meet the high standards already expected on a commercial poultry farm. The eradication program should include a control program to reduce the dispersal of rats and mice from the contaminated site (see also Section 2.2.10). Flying insects can spread the disease mechanically (see Section

1.6.3). If practical and appropriate, steps should be undertaken to reduce the numbers of flying insects and minimise the chance of flies entering bird sheds.

2.2.12 Sentinel and restocking measures

No repopulation can take place until at least 21 days after satisfactory cleaning and disinfection has been completed. Where cleaning and disinfection protocols have been modified with CCEAD approval and litter has been composted on site, three months of Australian summer between 1 December and 30 April should elapse before final disinfection of the premises and then restocking; otherwise, the period should be six months.

Experience has shown that dead-bird sampling of repopulated sheds is a more satisfactory method for monitoring the effectiveness of cleaning and disinfection than the placing of sentinel birds in the buildings from the time of depopulation to repopulation. However, this option has to be weighed against the possibility that infection has remained and that a second whole flock will have to be destroyed.

2.2.13 Public awareness

A media campaign needs to emphasise the importance of producers inspecting susceptible animals regularly and reporting suspicious clinical signs and unusual deaths promptly. Details of any imposed movement controls need to be readily available and clearly explained to and understood by industry. The public must not be panicked into avoiding poultry products. Although human infection with ND can occur occupationally, there is no established risk to the public from poultry products.

3 Policy and rationale

3.1 Introduction

Newcastle disease (ND) is an OIE-listed disease that has the potential for rapid spread and is important in the export, import and domestic trade in poultry, other birds and their products.

ND is an Animal Health Australia Category 3 disease under the government-industry EAD Response Agreement for cost-sharing arrangements. Category 3 diseases are those for which costs will be shared 50% by government and 50% by industry.

The policy is to eradicate ND in the shortest possible time, using the most appropriate strategy and taking into account whether the ND virus is of Australian or exotic origin, while limiting economic impact on the industry. This will be achieved using a combination of strategies, including:

- *stamping out*, which involves quarantine, slaughter of all infected and exposed susceptible birds on infected premises, and sanitary disposal of destroyed birds and contaminated avian products, to remove the source of infection;
- *quarantine and movement controls* on birds, avian products and other things in declared areas to prevent spread of infection;
- *decontamination* of facilities, products and other things to eliminate the virus on infected premises and to prevent spread in declared areas;
- *tracing and surveillance* to determine the source and extent of infection and to establish proof of freedom from the disease;
- *zoning* to define infected and disease-free areas;
- *a public awareness campaign* to facilitate cooperation from industry and the community; and
- *vaccination* that is nationally coordinated with stamping out and is under the strict control of the chief veterinary officer.

An uncontrolled outbreak of exotic ND would cause severe production losses with consequent dislocation and financial losses in the poultry and related industries. It will therefore be necessary to act immediately and effectively to control and then eradicate the disease.

There are already low-virulence strains of ND that cause no economic loss in Australian poultry flocks. ND virus isolates need to be pathotyped to define their virulence. Australian-origin ND can only be eradicated if the precursor lentogenic viruses are also eradicated and this is likely only if a long-term vaccination strategy is in place.

ND has no public health implications for people not occupationally exposed.

The chief veterinary officer (CVO) in the state or territory in which the outbreak occurs will be responsible for developing an emergency animal disease response plan (EAD Response Plan). This plan will be approved for technical soundness and consistency with AUSVETPLAN by governments and affected livestock industry technical representatives on the Consultative Committee on Emergency Animal Diseases (CCEAD). The plan will ultimately be approved and cost-shared by government chief executive officers and industry leaders through the national management group (NMG) of government and industry representatives established for the incident.

CVOs will implement disease control measures as agreed in the EAD Response Plan and in accordance with relevant legislation. They will make ongoing decisions on follow-up disease control measures in consultation with the CCEAD and the NMG. The detailed control measures adopted will be determined using the principles of control and eradication (Section 2) and epidemiological information about the outbreak.

For information on the responsibilities of state or territory disease control headquarters and local disease control centres, see the **Control Centres Management Manual, Part 1**.

3.2 Control and eradication policy

The objective is to eradicate the disease and to establish Australia's ND-free status in the shortest possible time. This will be achieved by a stamping-out and disinfection policy with the maintenance of strict quarantine and movement controls to reduce the spread of the disease, detailed and targeted surveillance and monitoring programs to determine the presence and distribution of the disease, disposal of infected and contaminated products and things as necessary, and intensive decontamination. Controls over the movement of poultry and humans in the outbreak area are the key factors in controlling and limiting the spread of ND. This program is most relevant for the eradication of exotic ND from Australia and the achievement of country free status.

Vaccine may be used in the control program to contain the disease or slow its spread, to enable the salvage of valuable genetic stock, or to suppress precursor and Australian-origin ND viruses. However, depending on the circumstances at the time, the following two options can be pursued for achieving eradication of ND:

- stamping out without vaccination; or
- stamping out with vaccination.

Both strategies require a strong commitment to surveillance to ensure that the goal of eradication is being achieved and that eradication is proven. The 2013 OIE Terrestrial Code states that ND free status can be regained 3 months after stamping out (including disinfection of all affected establishments), provided that surveillance has been applied in accordance with Article 10.13.22 during that 3-month period; it does not differentiate between stamping out with or without vaccination.

If the disease were to become very widespread, a third option might be implemented. This would involve removing all restrictions on the disease, such as the restrictions on infected premises and the movement of poultry, and allowing voluntary vaccination to enable commercial poultry producers to protect their stock (see Section 3.6 for further details). A declaration for country freedom for ND under this option would require extensive surveillance to support the application and would require more than three months after the last recorded outbreak of ND.

After a review of the strategies being applied to the control of Australian-origin ND viruses in December 2002, government and industry representatives supported the implementation of new priority management options, including the use of vaccination as part of the long-term management strategy to control and eradicate such viruses. States and territories will be designated either *vaccinating* or *non-vaccinating*, based on the risk assessment of likely infection with Australian-origin and precursor ND viruses. Vaccination in vaccinating areas was endorsed to be compulsory in accordance with nationally agreed standard operating procedures (SOPs) for vaccinating the various categories of poultry¹².

Where an outbreak occurs in a region that does not routinely vaccinate to prevent the emergence of Australian-origin ND, vaccination should be immediately considered as a routine biosecurity strategy.

Where an outbreak is detected in a routinely vaccinating area, the vaccination status of all chickens in the restricted area (RA) and control area (CA) must be assessed and action taken where necessary to ensure that flocks are protected according to standards agreed by CCEAD.

In moving to the eradication of Australian-origin and precursor ND viruses, the national management plan is based on a risk management approach to control of infection. The continuing assessment of risk will be based on the outcomes from monitoring and surveillance activities across Australia. Infections in flocks not complying with the national protocols, such as vaccination SOPs and biosecurity measures, may result in compensation and other benefits not being available to affected flock owners.

Regular liaison and communication with the poultry industry and government will be essential in making the decisions about how the eradication of ND can be achieved, or if and when the aim of eradication will be abandoned. The media and the public will need to be kept informed. At the farm level, a well-prepared poultry industry will prevent virus entry to its flocks by practising good hygiene and biosecurity measures, including:

- birdproofing houses, feed stores and water tanks;
- minimising, scrutinising and controlling movements onto and off premises;
- disinfecting all equipment, especially vehicles, before bringing on site;

¹² www.animalhealthaustralia.com.au/wp-content/uploads/2011/04/Newcastle-disease-vaccination-program-Standard-operating-procedures.pdf

- ensuring that all movements for collecting eggs or carcasses, feed delivery etc are from a designated collection and delivery point away from the poultry flock; and
- taking special precautions with bleeding and vaccinating teams, inseminators and veterinarians as they move between properties because, apart from live bird movements, human movements are the most likely way of introducing ND.

3.2.1 Stamping out

All birds on an infected premises (IP) will be subject to stamping out. Decisions on the destruction of birds on other premises will be based on the information that becomes available from tracing, surveillance and pathotyping of virus isolates. Note that the AUSVETPLAN definition of an IP is a defined area that may be all or part of a property (see Section 4).

3.2.2 Quarantine and movement controls

In the event of an ND outbreak, there will be a declaration of IPs and any dangerous contact premises (DCPs) or suspect premises (SPs). This will be supported by the declaration of two major disease control areas.

- A *restricted area* (RA), which will have a radius of 1-5 km around an IP and contain as many DCPs and SPs as possible, will wherever possible exclude major markets, processing plants and general service areas to facilitate continuing industry activity where disease control principles are not compromised. More than one RA may be declared.
- A *control area* (CA), which should have a boundary no closer to the RA boundary than about 2-10 km, will form a buffer between the infected and free areas. This will assist in containing the disease within the RA and will enable a level of responsible restrictions to be imposed and a reasonable level of commercial activity to continue.

The initial outer boundary of the CA may correspond with state/territory or other geopolitical borders. Later, this boundary should be amended on the basis of the epidemiological information obtained over time to enable as much normal commercial activity to continue as possible, in line with the accepted disease control measures.

IPs and DCPs will be subject to strict quarantine and movement controls as outlined in Section 4. The movement of people and vehicles will be controlled (prohibited to other premises with poultry) and comprehensive decontamination required before they leave the premises.

SPs will be subject to strict movement controls during investigations into the status of the premises and during the OIE-prescribed incubation period of 21 days. The movement of birds and things in and out of the area will be dependent on regular monitoring, inspections and the time elapsed relative to the incubation period. Birds of marketing age may be permitted to be processed under strict quarantine and surveillance.

Disease-free properties within the RA will be subject to movement controls depending on their location; the products involved; the availability and location of

hatcheries, processing and marketing establishments; and epidemiological investigations. Birds and products from disease-free premises and SPs within the RA will be allowed to enter the CA for processing and marketing subject to monitoring, inspections and consideration of the incubation period. Birds are to be confined and bird-proofing of premises should be implemented as soon as possible. Adoption of the new OIE compartmentalisation principles for ND (see Section 2.2.1) will allow a less rigorous program to be taken against caged and aviary birds and backyard poultry in the control and eradication of ND. There will generally be free movement of birds, products and things within the CA, subject to permit and inspections of premises; surveillance and monitoring; an upgrading of hygienic standards at processing establishments and marketing/distribution centres; and their operation under SOPs. In general, birds, products and things may enter the CA from the disease-free areas but permission will be required for movement out of the CA.

The status of premises should be updated regularly and restrictions on the movement of birds and products should be eased as circumstances permit. If flocks in a declared area are not depopulated, then the cost of keeping the birds beyond their normal market age will be substantial.

Any delays in the supply of product and day-old chicks would result in substantial costs and enormous disruption to normal industry activity. For these reasons, the size of the RA and CA declared should be made as small as is consistent with good disease-control practices.

See Section 4 for further details on quarantine and movement controls.

Zoning

Zoning should be introduced as soon as possible after the epidemiological investigations have been completed and the extent and severity of the disease has been determined.

Zoning has drawbacks in that the OIE requirements to protect disease-free areas from infection will restrict trade from the infected area(s) to the free areas. These restrictions will have to be worked through with industry before implementation. Additional surveillance in the free areas will be needed. The general OIE Terrestrial Code chapters on zoning and compartmentalisation (Chapter 4.3) and on animal health surveillance (Chapter 1.4), as well as the specific chapter on Newcastle disease (Chapter 10.13), will need to be taken into account if international recognition is to be achieved, thus facilitating exports from disease-free zones or compartments.

3.2.3 Tracing and surveillance

Trace-back and trace-forward will start immediately ND is suspected, in order to establish the extent of the RA and CA. Tracing will cover birds, products, feed, litter, waste, equipment and people. Trace-back will determine movements onto IPs and their origin up to 21 days before the earliest time mortality and morbidity were observed on the premises, consistent with the OIE incubation period. Tracing will locate additional IPs and identify DCPs and SPs. The original source of introduction of the virus should be traced, as it could remain a threat.

See Sections 2.2.2 and 2.2.3 for further details, including interpretation of serological results.

3.2.4 Vaccination

Vaccination may be approved for use in specified flocks under guidelines approved and agreed by the CCEAD and carried out under the strict control of the CVO. Where resources are limited, a suitable vaccine produced from a lentogenic strain may be used to reduce the volume of virus in an infected flock before stamping out. Vaccination can be used to establish a barrier of immune birds around an outbreak, to protect elite breeder flocks, or to protect backyard poultry and/or caged aviary birds (see Section 2.2.9). Vaccinated flocks must be identified and maintained under SOPs.

Where vaccine is used to establish a buffer of immune birds and the birds or premises do not become infected, the birds may be slaughtered and marketed under controlled SOPs after a suitable time has elapsed.

Approval to vaccinate genetically important foundation stock, which has been nominated by industry, may be given after agreement with the CCEAD. Agreed protocols for the collection and handling of fertile eggs need to have been developed as SOPs. Vaccinated flocks will remain in quarantine for the duration of the outbreak and until cleared of infection. If there is evidence of infection with virulent ND virus, the flocks will be destroyed. If not, they may be processed as usual at the end of their commercial life.

See Sections 1.5.3, and 2.2.9 for further details on vaccination, including vaccines available and methods of vaccination.

3.2.5 Treatment of infected birds

Treatment of birds for ND is not appropriate and is ineffective.

3.2.6 Treatment of poultry products and byproducts

Poultry products may need to be treated in certain circumstances. The treatment required will depend on the type of product, the nature of the declared area and the disease status of the premises. Stored and frozen products from SPs will not require treatment if the proper sanitisation procedures have been implemented, the premises has met flock inspection requirements and demonstrated negative serology, and the minimum incubation period has elapsed. All waste material must be decontaminated.

Cooked products from all sources except IPs and DCPs (unless vaccinated and with controlled infection), may be distributed for general commercial trade, provided that the products have met minimum time/temperature requirements during cooking and the products have been produced under SOPs for production, harvesting, processing and distribution. Care needs to be taken with flash-fried products (eg chicken nuggets for further cooking) that have not have met these minimum requirements; controlled distribution should ensure further cooking of these products (see Section 1.6.2).

Manure and litter treatment on site, or disposal after removal from the site, will require approval. Approval and treatment will depend on the disease status of a property (Section 4).

3.2.7 Disposal of animal products and byproducts

Poultry products on IPs and DCPs should be appropriately destroyed on site in most circumstances (see Section 4). Available methods for disposal include burial, incineration, burning, rendering and composting. For more information see the **Disposal Manual**.

3.2.8 Decontamination

Most ND virus is excreted from infected birds in faeces and is relatively stable in faeces and litter. Anything contaminated with either of these materials is therefore able to disseminate infection.

The virus is susceptible to a wide range of disinfectants, particularly those with detergents, but only if items are properly cleaned before being disinfected. Cleaning and disinfection of premises, things and people is an essential part of the stamping-out policy and must be rigorously applied. Where thorough cleaning and disinfection of IPs is not required, a modified cleaning and disinfection process can be worked out where additional time is allowed for destruction of virus; such times would normally be six months but would be reduced to three months in the hot Australian summer months.

3.2.9 Wild animal and vector control

Decontamination should include standard insect vector and rodent control to minimise mechanical spread of the agent to nearby premises.

To minimise the risk from wild birds, it is essential to practice high-level security. Birdproofing of quarantined and other poultry houses and protection of contaminated sites from birds during eradication procedures should be encouraged.

3.2.10 Public awareness and media

See Section 2.2.13 for further details on what to include in a public awareness campaign.

3.2.11 Public health implications

ND has no public health implications for people not occupationally exposed.

3.3 Other policies

If there are widespread foci of ND, there are four strategic options:

- continue stamping out;
- continue stamping out with compulsory vaccination;
- compulsory vaccination without stamping out; or
- relaxation of all controls and allow voluntary vaccination.

Any one of these options may result in prolonged losses to the poultry industry, including the ancillary service and sales sections.

If the number of disease foci exceeds the resources available for stamping out, or if the initial strategy is failing, one of the other three options will need to be considered in close consultation with industry and consciously adopted as the disease control strategy.

The major issue of concern is that the time to obtain ND-free status will be prolonged if vaccination is the primary disease control measure; this needs to be offset against the high costs and losses if stamping out continues to be the primary measure. Vaccination alone will not be covered under the government–industry cost-sharing arrangement, unless there is a clear short-term commitment to achieve eradication.

The acceptance of zoning may be an important factor in selecting one of the four strategic options. However, this decision must take account of the cost of this approach as a result of restrictions on movements from the infected zone.

Whichever option is selected, there will be a need for constant liaison with industry, the media and the public, together with a detailed education program and advice to producers on the disease, the control options and the best methods of handling the situation, including:

- means of prevention of infection (e.g. water treatment, bird proofing, pest control, isolation, hygienic practices, tightening up of biosecurity measures); and
- disease monitoring, flock examinations and rapid reporting of unusual events.

3.4 Funding and compensation

Newcastle disease is classified as a Category 3 emergency animal disease under the EAD Response Agreement between the governments of Australia and the livestock industries.

Category 3 diseases are emergency animal diseases that have the potential to cause significant (but generally moderate) national socioeconomic consequences through international trade losses, market disruptions involving two or more states and severe production losses to affected industries, but have minimal or no effect on human health or the environment. For this category, the costs will be shared 50% by governments and 50% by the relevant industries (refer to the EAD Response Agreement for details).¹³

Information on the cost-sharing arrangements can be found in the **AUSVETPLAN Summary Document** and in the **Valuation and Compensation Manual**.

¹³ Information about the EAD Response Agreement can be found at:
www.animalhealthaustralia.com.au/programs/emergency-animal-disease-preparedness/ead-response-agreement

4 Recommended quarantine and movement controls

4.1 Guidelines for classifying declared areas and premises

4.1.1 Premises

Infected premises

Premises classified as an IP will be a defined area (which may be all or part of a property) in which an endemically derived or exotic virulent ND virus exists, or is believed to exist. An IP is subject to quarantine served by notice and to eradication or control procedures.

Dangerous contact premises

A premises classified as a DCP will be one that contains birds not showing clinical signs of ND but that, following a risk assessment, is considered highly likely to contain infected birds or contaminated avian products, wastes or things, that present an unacceptable risk to the response if not addressed.

Premises classified as DCPs will be those that contain birds, poultry products, poultry waste or things that have recently been introduced from an IP (usually up to 21 days before the premises were declared infected), or any of these items that may have been in substantial contact with people and equipment that have been associated with an IP within three days of visiting the DCP. A DCP is subject to disease control procedures.

Suspect premises

Premises classified as SPs will be those that contain birds not known to have been exposed to an ND virus, but are showing clinical signs requiring differential diagnosis.

The classification 'suspect premises' is a temporary classification because the premises contains birds that are suspected of having the disease. High priority should be given to clarifying the status of the suspect birds so that the SP can be reclassified as either an IP and appropriate quarantine and movement controls implemented, or as free from disease, in which case no further disease control measures are required.

Trace premises

A TP is a temporary designation applied to premises that contain birds that tracing indicates may have been exposed to an infected bird or contaminated avian products, wastes or things, and that require investigation.

4.1.2 Areas

Restricted area

An RA will be a relatively small declared area (compared to a *control area*) around 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 area would only be by permit. Multiple RAs may exist within one CA.

The RA does not need to be circular but can have an irregular perimeter provided the boundary is initially an appropriate distance from the nearest IP, DCP or SP. This distance will vary with the size and nature of the potential source of virus, but will be in the order of 1–5 km around the IP, depending on the density of poultry premises. The boundary could be the perimeter fence of the IP if the IP is in an isolated location. The boundary in a densely populated area will take into account the distribution of susceptible birds and traffic patterns to markets, service areas, abattoirs and areas that constitute natural barriers to movement. If possible, hatcheries should be kept out of the RA.

Control area

The CA will be a larger declared area around the RA(s) and, initially, possibly as large as a state. In the CA, restrictions will reduce the risk of disease spreading from the RA. The boundary of the CA will be altered as confidence about the extent of the outbreak becomes clearer. The CA must remain consistent with the OIE Terrestrial Code chapters on surveillance and zoning. In general, surveillance and movement controls will be less intense and animals and products may be permitted to move under permit from the area.

The CA is a buffer zone between the RA and the rest of the industry. The boundary does not have to be circular or parallel to that of the RA but should be 2–10 km from the boundary of the RA.

Note: When RAs and CAs are declared, the areas must not be larger than necessary. The quarantining of properties will thus be restricted to only the extent deemed prudent. If flocks in a quarantine area are not depopulated, the cost of keeping the birds beyond their normal market age could be substantial.

4.2 Movement controls for Newcastle disease

4.2.1 Declared premises

Table 4.1 Movement controls for declared premises

Quarantine/movement control	Infected premises and dangerous contact premises	Suspect premises
Movement out of birds	Prohibited. All birds on an IP are to be slaughtered on site. Rapid assessment and intense surveillance of DCPs will decide whether birds will be destroyed or the premises will be treated as 'suspect'.	Prohibited except by permit for immediate slaughter at an abattoir and subject to strict quarantine and disinfection procedures. Subject to intense surveillance (note 1).
<i>Movement in of susceptible birds</i>	Prohibited.	Allowed by permit. Subject to surveillance (note 2).
<i>Movement out of other animals</i>	Prohibited.	Allowed by permit (note 3).
<i>Movement out of litter and manure</i>	Prohibited.	Prohibited.
<i>Movement out of equipment and feed</i>	Prohibited except by permit (note 4).	Prohibited except by permit.
<i>Movement in and out of people</i>	Allowed by permit. Subject to strict quarantine and disinfection procedures.	Allowed by permit. Subject to strict quarantine and disinfection procedures.
<i>Movement in and out of vehicles</i>	Subject to the security arrangements in place at the premises.	Allowed by permit. Subject to strict quarantine and disinfection procedures.
<i>Movement of fertile eggs</i>	Prohibited. To be destroyed on the premises, except for salvage of genetic stock (note 5).	Allowed by permit. Subject to strict quarantine, disinfection and transport controls.
Movement of table eggs	Prohibited. Eggs to be destroyed on site.	Allowed by permit. Subject to sanitisation procedures.
<i>Movement of fresh/frozen meat from birds</i>	Prohibited. Meat to be destroyed on site, or otherwise by CVO instruction.	Fresh/frozen retail sales allowed except when birds have not been inspected before slaughter. Allowed by permit to be further processed or cooked outside the RA.
<i>Movement in of feed</i>	Allowed by permit to supply feed to remaining birds on a DCP.	Allowed by permit. Subject to strict quarantine and disinfection procedures.

Quarantine/movement control	Infected premises and dangerous contact premises	Suspect premises
<i>To and from hatcheries</i>	Prohibited.	Movement in and out permitted provided that the fertile eggs, chicks and hatchery waste are from an ND-free source and the breeding flocks are serologically monitored weekly.
<i>To and from processing plants</i>	If the plant received birds from an IP or DCP, it should be cleaned and disinfected <i>under supervision</i> before operating again. Stored fresh and frozen carcasses from an IP or DCP should be destroyed.	If the plant received birds from an SP, it should be cleaned and disinfected <i>under supervision</i> before operating again.
<i>Movement of abattoir waste</i>	Operations suspended. Waste buried on site or removed under permit, subject to strict disinfection procedures.	Allowed by permit within the RA, subject to strict disinfection procedures.
<i>Movement out of dead birds</i>	Prohibited. Dispose of on site, or in RA by permit subject to strict quarantine and disinfection.	Allowed by permit within the RA.
<i>Movement out of horticultural and agricultural crops</i>	Allowed.	Allowed.

Table 4.2 Movement controls for declared areas

Quarantine/movement control	Restricted area	Control area
<i>General</i>	All premises to operate biosecurity at a high level according to standard operating procedures (SOPs).	All premises to operate biosecurity at a high level according to SOPs.
<i>Movement out of birds</i>	Prohibited.	Prohibited, except by permit (note 2).

Quarantine/movement control	Restricted area	Control area
<i>Movement in of birds</i>	Movement from a free area or contiguous CA to a clean abattoir for immediate slaughter is allowed by permit. Restocking may be allowed by CVO approval.	Movement from a free area to a property or abattoir is allowed by permit.
<i>Movement within of birds</i>	Movement to an abattoir for immediate slaughter or to a property may be allowed by permit. Surveillance will provide confidence in allowing processing of marketable birds.	Movement is allowed in the CA (including to slaughter). Surveillance will provide confidence in allowing processing of marketable birds.
<i>Movement through of birds</i>	Direct movement by air, road or rail may be allowed by permit, provided that the origin and destination are both outside the RA and CA. If transport is delayed within the CA, the birds should be regarded as suspect and their further movement reassessed.	Allowed.
<i>Movement out of litter and manure</i>	Prohibited.	Prohibited, except by permit.
<i>Movement out of equipment and feed</i>	Allowed by permit (note 4).	Allowed.
<i>To and from hatcheries</i>	If possible, hatcheries should be kept out of declared RAs. Activities will be suspended.	Fertile eggs may have to be sourced from outside the CA. Permits for day-old chicks to be supplied to properties outside the CA may be required.
<i>To and from processing plants</i>	Activities will be suspended. If possible, processing plants should be kept out of declared RAs.	Poultry from the CA can be processed following on-farm inspection within the previous 24 hours. Equipment to be cleaned and disinfected at the end of the day. Poultry from outside the CA can be slaughtered subject to vehicle disinfection before leaving the CA.

Quarantine/movement control	Restricted area	Control area
<i>Movement of meat, offal and waste from susceptible birds</i>	Movement into or within the RA is allowed. Movement out of the RA is prohibited except by permit to approved premises for heat treatment.	Movement into or within the CA is allowed. Movement out of the CA may be allowed by permit, preferably after processing.
<i>Risk enterprises, eg private avian laboratories, cull hen collectors, dead bird pick-up (not processing establishments)</i>	Operations suspended.	May continue to operate by permit.
<i>Sales, shows, pigeon races etc</i>	All gatherings of susceptible birds are prohibited.	May continue to operate by permit.
<i>Movement of table eggs in or out, other than from IPs and DCPs</i>	Allowed by permit subject to sanitising procedures.	Allowed into, within or out of the CA by permit. Allowed by permit into the RA.
<i>Movement of fertile eggs</i>	Not allowed from IPs and DCPs except by permit for genetic salvage. Allowed by permit (note 6) subject to strict quarantine, disinfection and subsequent surveillance, and specified transport procedures.	Allowed within the CA. Allowed by permit out of the CA, subject to upgraded hygiene procedures and subsequent surveillance.
<i>Movement of egg pulp from plants, including on-farm plants</i>	Prohibited, except by permit for heat treatment.	Allowed within the CA. Permit required to move outside the CA.
<i>Control of domestic pets and poultry</i>	Within the RA, all pets are to be confined or tied up and all free poultry are to be confined.	As for RA.

Notes:

- (1) If the CA contains an appropriate place for poultry slaughter, permission should be given to remove meat birds from DCPs and SPs, following inspection within 24 hours, for slaughter where no sign of infection has developed during the declared incubation period and surveillance has been in place. This represents a reduced risk of infected birds being removed, which is further reduced by the cooking processes. If movement is carried out with strict supervision of quarantine and hygiene procedures, this risk should be greatly preferable to the virus 'factory' that would result from the development of clinical disease.
- (2) Permits for movement of susceptible birds onto an SP or into an RA or CA should be issued with caution. Although such movements may pose no risk of spreading infection, compensation would be payable if these animals became infected or needed

to be destroyed. Birds must remain on the property for at least 21 days and be inspected before any further movement.

- (3) Stock must not have had direct or indirect contact with poultry for 21 days before movement.
- (4) Feed that has been exposed to susceptible birds should be prohibited from leaving the premises.
- (5) Fumigation of eggs, together with strict hatchery hygiene, has been considered as a means of salvaging genetic stock from uninfected eggs in an infected flock. Strict protocols will be needed along with quarantine and intensive monitoring of flocks hatched from these eggs.

4.3 Criteria for issuing permits

When conducting a risk assessment regarding the issue of a permit, the officer should take into account the following:

- status of the originating and destination premises;
- species of animal;
- confidence in animal identification;
- destination and use of the animals or products;
- likelihood of contamination of the product or material (ie ability to decontaminate);
- security of transport; and
- potential harbours for vectors (ie ability to decontaminate).

Appendix 1 Procedures for surveillance and proof of freedom

While the purpose of the control program is to achieve eradication, surveillance is the essential tool for achieving the objective. The intensity of surveillance required for *stamping out without vaccination* will need to be higher than for *stamping out with vaccination*, which, in turn, needs to be higher than for *eradication by vaccination without stamping out*.

The purpose of surveillance is to identify potential new cases. Because of the risk of spread of virus by personnel, equipment and vehicles, the following procedures should be adopted to enable continuing surveillance while minimising multiple farm visits to premises in the RA and CA by inspectors and industry personnel:

- dead bird pick-up and transport to a laboratory, or sampling for virology and sending to a laboratory;
- reporting on flock health statistics by telephone or fax;
- adopting telephone surveying where practicable to obtain meaningful results;
- serological testing for evidence of ND flock infection, and immunity levels if vaccinating; and
- arranging visits only to potential new cases identified by the above methods.

This does not reduce the value of having staff visit premises to discuss issues about the flock and the biosecurity measures at the site, even if the poultry premises themselves are not entered. Random visits by surveillance officers provide assurance to the industry about the integrity of a control strategy. The focus of surveillance has to be on commercial poultry operations. In planning a surveillance program, it is important to first identify all premises with poultry and the types of poultry on those premises.

There are three phases of surveillance:

- early in an outbreak, to define the extent of infection;
- later in an outbreak when recovered flocks have seroconverted and when detecting residual infection; and
- if the disease is established and vaccination becomes the primary method of eradication, to provide proof of eradication.

Training needs

Surveillance officers must:

- be familiar with the poultry industry; or
- pass information to poultry industry experts for interpretation.

Surveillance/authorised officers must have access to:

- flock health records expected for the class of stock under normal circumstances;
- a summary of the disease – a list, pictures and video of clinical signs and an example of how health and production records would change in flocks infected with virulent ND virus.

Information required

Information will be required from high-risk flocks in the RA and CA and, where the disease has spread, information will need to be collected from a wider area. The high-risk flocks might be:

<i>Commercial poultry:</i>	<i>Domestic non-commercial:</i>	<i>Other:</i>
breeders	pigeons	backyard flocks
started pullets	aviaries	fancy flocks
layers	pet shops	
meat chickens		
turkeys		
game birds		

A reporting procedure, which includes the following observations, should be adopted.

Examination of flock records provided by owners and by interviews of owners/staff for the following:

- any decline in feed or water consumption;
- any decline in egg production from normal to complete cessation, and/or abnormal eggshells;
- any increase in mortality; and
- any decline in hatchability.

Examination of flocks for the following:

- any respiratory disease;
- sudden drop in egg production and/or soft-shell eggs;
- any flock depression;
- any nervous signs; and
- any wet-dropping problems.

Field autopsy findings that include any of the following:

- cyanosis of the comb;
- haemorrhages and necrosis in the proventriculus, gizzard and lymphoid tissues in small intestine and caecal tonsils;
- petechial haemorrhage on other organs or in the trachea;
- catarrhal or congestive tracheitis;

- laryngitis; and
- thickened, cloudy air sacs.

Decisions should be made at the local disease control centre about the laboratories to be responsible for sample testing and who will manage and evaluate the results in following situations:

- before a diagnosis is confirmed;
- after a diagnosis is confirmed (CVO to decide whether diagnosis is to be on clinical signs or laboratory investigation); and
- after repopulation of IPs and DCPs (see Section 2.2.12).

Procedures during the outbreak

In the RA. Surveillance is to begin once the CA has been declared. Arrangements should be made for local laboratories to autopsy samples of all species of bird that are found dead or to collect pooled swabs of trachea and cloaca separately where examination of the birds is impractical. Flock health can be monitored by:

- twice-weekly (or more frequently if needed) telephone/fax reporting by commercial producers and dead bird pick-up with field visit, if needed;
- twice-weekly (or more frequently if needed) telephone surveillance of SPs and dead bird pick-up and field visit, if needed;
- random visits to properties to discuss production performance and biosecurity measures;
- swabbing dead birds (trachea and cloaca) for virus isolation weekly for SPs and fortnightly for other premises;
- where vaccination is not being practised, serological sampling of flocks to provide a 95% level of confidence that virulent ND virus is not present at the 5% level (titres of $>2^{10}$, or samples in which $>25\%$ of the sample is $>2^5$, should be viewed with suspicion); and
- quarantining of suspicious flocks, virus isolation and resampling after seven days.

In the CA. Surveillance in the CA will begin immediately the RA has been declared and will involve:

- weekly telephone surveillance of susceptible flocks, including other species, with particular focus on commercial poultry;
- swabbing dead birds (trachea and cloaca) for virus isolation at a level sufficient to determine infection with virulent virus in the highest priority commercial flocks, particularly those to be moved to slaughter;
- serological sampling of suspicious flocks and of a representative sample of commercial poultry flocks to provide a 95% level of confidence that the virulent ND virus is not present at the 5% level in the flock (titres of $>2^{10}$, or

samples in which >25% of the sample is >2⁵, should be viewed with suspicion)
– meat chickens and spent hens can be sampled at the abattoir;

- weekly reporting on flock health by producers and random visits to discuss flock performance and biosecurity measures;
- follow-up on any unusual disease conditions; and
- quarantining of suspicious flocks, virus isolation and resampling of flocks after seven days.

Wider geographical surveys

Wider geographical surveys may be required within the disease-free area if there has been transport of birds or other links from the RA and/or CA before the disease was recognised. Such surveys should start as soon as there is confidence that the outbreak has been controlled. Surveys should aim at a 95% confidence level of detecting a 5% infection rate in at least 1% of the commercial flocks.

Procedures to establish proof of freedom

Area proof of freedom will be decided on the body of evidence to hand that no virulent virus infection remains in the RA or infected zone; this can only come from the cumulative evidence obtained from the surveillance carried out during and after the period of infection. The evidence also needs to be of such dimension that trading partners will accept it.

Proof of freedom from ND on previously depopulated premises can best be achieved by clinical observations and dead-bird sampling of repopulated sheds or sentinel birds, and investigation of possible disease outbreaks, rather than by widespread serological testing.

Some serological surveillance will be required and it is recommended that this be performed on former IPs, DCPs and SPs, at 30 days after restocking and at five months to establish a 95% confidence of detecting infection at less than 5%. This is to be supported by twice-weekly clinical examinations for 30 days, then fortnightly for five months, and virus isolation carried out on dead birds. Seropositive flocks will require further investigation and virus isolation.

Further testing may be considered in other areas if the epidemiological information suggests that this is warranted.

Glossary

Agriculture Ministers' Forum	The council of Australian national, state and territory and New Zealand ministers of agriculture that sets Australian and New Zealand agricultural policy (formerly the Primary Industries Ministerial Council). <i>See also</i> Animal Health Committee
Animal byproducts	Products of animal origin that are not for consumption but are destined for industrial use (eg hides and skins, fur, wool, hair, feathers, hooves, bones, fertiliser).
Animal Health Committee	A committee whose members are the Australian and state and territory CVOs, the Director of the CSIRO Australian Animal Health Laboratory, and the Director of Environmental Biosecurity in the Australian Government Department of the Environment. The committee provides advice to the Agriculture Ministers' Forum on animal health matters, focusing on technical issues and regulatory policy (formerly called the Veterinary Committee). <i>See also</i> Agriculture Ministers' Forum
Animal products	Meat, meat products and other products of animal origin (eg eggs, milk) for human consumption or for use in animal feedstuff.
Approved processing facility	An abattoir, knackery, milk processing plant or other such facility that maintains increased biosecurity standards. Such a facility could have animals or animal products introduced from lower risk premises under a permit for processing to an approved standard.
At-risk premises	A premises in a restricted area that contains a live susceptible animal(s) but is not considered at the time of classification to be an infected premises, dangerous contact premises, dangerous contact processing facility, suspect premises or trace premises.
Australian Chief Veterinary Officer	The nominated senior veterinarian in the Australian Government Department of Agriculture who manages international animal health commitments and the Australian Government's response to an animal disease outbreak. <i>See also</i> Chief veterinary officer (CVO)
AUSVETPLAN	<i>Australian Veterinary Emergency Plan</i> . A series of technical response plans that describe the proposed Australian approach to an emergency animal disease incident. The documents provide guidance based on sound analysis, linking policy, strategies, implementation, coordination and emergency-management plans.

Chief veterinary officer (CVO)	<p>The senior veterinarian of the animal health authority in each jurisdiction (national, state or territory) who has responsibility for animal disease control in that jurisdiction.</p> <p><i>See also</i> Australian Chief Veterinary Officer</p>
Compartmentalisation	<p>The process of defining, implementing and maintaining one or more disease-free establishments under a common biosecurity management system in accordance with OIE guidelines, based on applied biosecurity measures and surveillance, in order to facilitate disease control and/or trade.</p>
Compensation	<p>The sum of money paid by government to an owner for livestock or property that are destroyed for the purpose of eradication or prevention of the spread of an emergency animal disease, and livestock that have died of the emergency animal disease.</p> <p><i>See also</i> Cost-sharing arrangements, Emergency Animal Disease Response Agreement</p>
Consultative Committee on Emergency Animal Diseases (CCEAD)	<p>The key technical coordinating body for animal health emergencies. Members are state and territory CVOs, representatives of CSIRO-AAHL and the relevant industries, and the Australian CVO as chair.</p>
Contagious disease	<p>An infectious disease that can be transmitted from one animal or person to another (also called a communicable disease). Contagious diseases are often spread through direct contact, contact with body fluids or contact with objects that an infected individual has contaminated (fomites).</p> <p><i>See also</i> Infectious disease</p>
Control area (CA)	<p>A legally declared area where the disease controls, including surveillance and movement controls, applied are of lesser intensity than those in a restricted area (the limits of a control area and the conditions applying to it can be varied during an incident according to need).</p>
Cost-sharing arrangements	<p>Arrangements agreed between governments (national and states/territories) and livestock industries for sharing the costs of emergency animal disease responses.</p> <p><i>See also</i> Compensation, Emergency Animal Disease Response Agreement</p>
Dangerous contact animal	<p>A susceptible animal that has been designated as being exposed to other infected animals or potentially infectious products following tracing and epidemiological investigation.</p>

Dangerous contact premises (DCP)	A premises, apart from an abattoir, knackery or milk processing plant (or other such facility) that, after investigation and based on a risk assessment, is considered to contain a susceptible animal(s) not showing clinical signs, but considered highly likely to contain an infected animal(s) and/or contaminated animal products, wastes or things that present an unacceptable risk to the response if the risk is not addressed, and that therefore requires action to address the risk.
Dangerous contact processing facility (DCPF)	An abattoir, knackery, milk processing plant or other such facility that, based on a risk assessment, appears highly likely to have received infected animals, or contaminated animal products, wastes or things, and that requires action to address the risk.
Declared area	A defined tract of land that is subjected to disease control restrictions under emergency animal disease legislation. There are two types of declared areas: restricted area and control area.
Decontamination	Includes all stages of cleaning and disinfection.
Depopulation	The removal of a host population from a particular area to control or prevent the spread of disease.
Destroy (animals)	To kill animals humanely.
Destruction	The killing of an animal using an approved method during a disease response.
Disease agent	A general term for a transmissible organism or other factor that causes an infectious disease.
Disease Watch Hotline	24-hour freecall service for reporting suspected incidences of exotic diseases – 1800 675 888 .
Disinfectant	A chemical used to destroy disease agents outside a living animal.
Disinfection	The application, after thorough cleansing, of procedures intended to destroy the infectious or parasitic agents of animal diseases, including zoonoses; applies to premises, vehicles and different objects that may have been directly or indirectly contaminated.
Disinsection	The destruction of insect pests, usually with a chemical agent.
Disposal	Sanitary removal of animal carcasses, animal products, materials and wastes by burial, burning or some other process so as to prevent the spread of disease.

Emergency animal disease	<p>A disease that is (a) exotic to Australia or (b) a variant of an endemic disease or (c) a serious infectious disease of unknown or uncertain cause or (d) a severe outbreak of a known endemic disease, and that is considered to be of national significance with serious social or trade implications.</p> <p><i>See also</i> Endemic animal disease, Exotic animal disease</p>
Emergency Animal Disease Response Agreement	<p>Agreement between the Australian and state/territory governments and livestock industries on the management of emergency animal disease responses. Provisions include participatory decision making, risk management, cost sharing, the use of appropriately trained personnel and existing standards such as AUSVETPLAN.</p> <p><i>See also</i> Compensation, Cost-sharing arrangements</p>
Endemic animal disease	<p>A disease affecting animals (which may include humans) that is known to occur in Australia.</p> <p><i>See also</i> Emergency animal disease, Exotic animal disease</p>
Enterprise	<p><i>See</i> Risk enterprise</p>
Enzyme-linked immunosorbent assay (ELISA)	<p>A serological test designed to detect and measure the presence of antibody or antigen in a sample. The test uses an enzyme reaction with a substrate to produce a colour change when antigen-antibody binding occurs.</p>
Epidemiological investigation	<p>An investigation to identify and qualify the risk factors associated with the disease.</p> <p><i>See also</i> Veterinary investigation</p>
Epidemiology	<p>The study of disease in populations and of factors that determine its occurrence.</p>
Exotic animal disease	<p>A disease affecting animals (which may include humans) that does not normally occur in Australia.</p> <p><i>See also</i> Emergency animal disease, Endemic animal disease</p>
Exotic fauna/feral animals	<p><i>See</i> Wild animals</p>
Export slaughter interval	<p>The time that should elapse between administration of a veterinary chemical to animals and their slaughter for export.</p>
Fluorescent antibody test	<p>Use of a fluorescently tagged antibody to detect a specific antigen.</p>
Fomites	<p>Inanimate objects (eg boots, clothing, equipment, instruments, vehicles, crates, packaging) that can carry an infectious disease agent and may spread the disease through mechanical transmission.</p>

General permit (GP)	<p>A legal document that describes the requirements for movement of an animal (or group of animals), commodity or thing, for which permission may be granted without the need for direct interaction between the person moving the animal(s), commodity or thing and a government veterinarian or inspector. The permit may be completed via a webpage or in an approved place (such as a government office or commercial premises). A printed version of the permit must accompany the movement. The permit may impose preconditions and/or restrictions on movements.</p> <p><i>See also</i> Special permit</p>
In-contact animals	<p>Animals that have had close contact with infected animals, such as noninfected animals in the same group as infected animals.</p>
Incubation period	<p>The period that elapses between the introduction of the pathogen into the animal and the first clinical signs of the disease.</p>
Index case	<p>The first case of the disease to be diagnosed in a disease outbreak.</p> <p><i>See also</i> Index property</p>
Index property	<p>The property on which the index case is found.</p> <p><i>See also</i> Index case</p>
Infected premises (IP)	<p>A defined area (which may be all or part of a property) on which animals meeting the case definition are or were present, or the causative agent of the emergency animal disease exists, or there is a reasonable suspicion that either exists, and that the relevant chief veterinary officer or their delegate has declared to be an infected premises.</p>
Infectious disease	<p>A disease that results from the presence and activity of one or more pathogenic microbial agents, including viruses, bacteria, fungi, protozoa, multicellular parasites and prions. Transmission of an infectious disease may occur through several pathways, including through contact with infected individuals (in the case of contagious diseases), by water, food or airborne inhalation, or through vector-borne spread.</p> <p><i>See also</i> Contagious disease</p>
Local control centre (LCC)	<p>An emergency operations centre responsible for the command and control of field operations in a defined area.</p>
Modified stamping out	<p>Any variation to <i>stamping out</i>.</p>
Monitoring	<p>Routine collection of data for assessing the health status of a population.</p> <p><i>See also</i> Surveillance</p>

Movement control	Restrictions placed on the movement of animals, people and other things to prevent the spread of disease.
National management group (NMG)	A group established to approve (or not approve) the invoking of cost sharing under the Emergency Animal Disease Response Agreement. NMG members are the Secretary of the Australian Government Department of Agriculture as chair, the chief executive officers of the state and territory government parties, and the president (or analogous officer) of each of the relevant industry parties.
Native wildlife	<i>See</i> Wild animals
OIE Terrestrial Code	OIE <i>Terrestrial Animal Health Code</i> . Describes standards for safe international trade in animals and animal products. Revised annually and published on the internet at: www.oie.int/en/international-standard-setting/terrestrial-code/access-online .
OIE Terrestrial Manual	OIE <i>Manual of Diagnostic Tests and Vaccines for Terrestrial Animals</i> . Describes standards for laboratory diagnostic tests and the production and control of biological products (principally vaccines). The current edition is published on the internet at: www.oie.int/en/international-standard-setting/terrestrial-manual/access-online .
Operational procedures	Detailed instructions for carrying out specific disease control activities, such as disposal, destruction, decontamination and valuation.
Outside area (OA)	The area of Australia outside the declared (control and restricted) areas.
Owner	Person responsible for a premises (includes an agent of the owner, such as a manager or other controlling officer).
Polymerase chain reaction (PCR)	A method of amplifying and analysing DNA sequences that can be used to detect the presence of viral DNA.
Premises	A tract of land including its buildings, or a separate farm or facility that is maintained by a single set of services and personnel.
Premises of relevance (POR)	A premises in a control area that contains a live susceptible animal(s) but is not considered at the time of classification to be an infected premises, suspect premises, trace premises, dangerous contact premises or dangerous contact processing facility.
Prevalence	The proportion (or percentage) of animals in a particular population affected by a particular disease (or infection or positive antibody titre) at a given point in time.

Quarantine	Legal restrictions imposed on a place or a tract of land by the serving of a notice limiting access or egress of specified animals, persons or things.
Resolved premises (RP)	An infected premises, dangerous contact premises or dangerous contact processing facility that has completed the required control measures and is subject to the procedures and restrictions appropriate to the area in which it is located.
Restricted area (RA)	A relatively small legally declared area around infected premises and dangerous contact premises that is subject to disease controls, including intense surveillance and movement controls.
Risk enterprise	A defined livestock or related enterprise that is potentially a major source of infection for many other premises. Includes intensive piggeries, feedlots, abattoirs, knackeries, saleyards, calf scales, milk factories, tanneries, skin sheds, game meat establishments, cold stores, artificial insemination centres, veterinary laboratories and hospitals, road and rail freight depots, showgrounds, field days, weighbridges, garbage depots.
Sensitivity	The proportion of truly positive units that are correctly identified as positive by a test. <i>See also</i> Specificity
Sentinel animal	Animal of known health status that is monitored to detect the presence of a specific disease agent.
Seroconversion	The appearance in the blood serum of antibodies (as determined by a serology test) following vaccination or natural exposure to a disease agent.
Serosurveillance	Surveillance of an animal population by testing serum samples for the presence of antibodies to disease agents.
Serotype	A subgroup of microorganisms identified by the antigens carried (as determined by a serology test).
Serum neutralisation test	A serological test to detect and measure the presence of antibody in a sample. Antibody in the test serum is serially diluted to detect the highest dilution that neutralises a standard amount of antigen. The neutralising antibody titre is given as the reciprocal of this dilution.
Slaughter	The humane killing of an animal for meat for human consumption.

Special permit (SpP)	<p>A legal document that describes the requirements for movement of an animal (or group of animals), commodity or thing, for which the person moving the animal(s), commodity or thing must obtain prior written permission from the relevant government veterinarian or inspector. A printed version of the permit must accompany the movement. The permit may impose preconditions and/or restrictions on movements.</p> <p><i>See also</i> General permit</p>
Specificity	<p>The proportion of truly negative units that are correctly identified as negative by a test.</p> <p><i>See also</i> Sensitivity</p>
Stamping out	<p>The strategy of eliminating infection from premises through the destruction of animals in accordance with the particular AUSVETPLAN manual, and in a manner that permits appropriate disposal of carcasses and decontamination of the site.</p>
State coordination centre (SCC)	<p>The emergency operations centre that directs the disease control operations to be undertaken in that state or territory.</p>
Surveillance	<p>A systematic program of investigation designed to establish the presence, extent or absence of a disease, or of infection or contamination with the causative organism. It includes the examination of animals for clinical signs, antibodies or the causative organism.</p>
Susceptible animals	<p>Animals that can be infected with a particular disease.</p>
Suspect animal	<p>An animal that may have been exposed to an emergency disease such that its quarantine and intensive surveillance, but not pre-emptive slaughter, is warranted.</p> <p><i>or</i></p> <p>An animal not known to have been exposed to a disease agent but showing clinical signs requiring differential diagnosis.</p>
Suspect premises (SP)	<p>Temporary classification of a premises that contains a susceptible animal(s) not known to have been exposed to the disease agent but showing clinical signs similar to the case definition, and that therefore requires investigation(s).</p>
Trace premises (TP)	<p>Temporary classification of a premises that contains susceptible animal(s) that tracing indicates may have been exposed to the disease agent, or contains contaminated animal products, wastes or things, and that requires investigation(s).</p>
Tracing	<p>The process of locating animals, persons or other items that may be implicated in the spread of disease, so that appropriate action can be taken.</p>

Transmission area (TA)	An area, not legally declared, that is used for vector-borne diseases for epidemiological purposes, recognising that vectors are not confined by property boundaries. It includes infected premises and, where possible, suspect premises, trace premises, dangerous contact premises and dangerous contact processing facilities. A transmission area is subject to an increased level of surveillance, and has movement controls appropriate to its associated restricted area.
Unknown status premises (UP)	A premises within a declared area where the current presence of susceptible animals and/or risk products, wastes or things is unknown.
Vaccinated premises	A premises on which an approved vaccination program (as defined in the emergency animal disease response plan) has been completed.
Vaccination	Inoculation of individuals with a vaccine to provide active immunity.
Vaccine	A substance used to stimulate immunity against one or several disease-causing agents to provide protection or to reduce the effects of the disease. A vaccine is prepared from the causative agent of a disease, its products, or a synthetic substitute, which is treated to act as an antigen without inducing the disease.
- attenuated	A vaccine prepared from infective or 'live' microbes that are less pathogenic but retain their ability to induce protective immunity.
- inactivated	A vaccine prepared from a virus that has been inactivated ('killed') by chemical or physical treatment.
- recombinant	A vaccine produced from viruses or bacteria that have been genetically engineered to contain only selected genes, including those causing the immunogenic effect.
- subunit	A vaccine consisting of a purified protective protein or epitope from a disease-causing agent, which is produced by recombinant DNA or synthetic peptide technology.
Vector	A living organism (frequently an arthropod) that transmits an infectious agent from one host to another. A <i>biological</i> vector is one in which the infectious agent must develop or multiply before becoming infective to a recipient host. A <i>mechanical</i> vector is one that transmits an infectious agent from one host to another but is not essential to the life cycle of the agent.
Veterinary investigation	An investigation of the diagnosis, pathology and epidemiology of the disease. <i>See also</i> Epidemiological investigation
Viraemia	The presence of viruses in the blood.

Wild animals

- native wildlife Animals that are indigenous to Australia and may be susceptible to emergency animal diseases (eg bats, dingoes, marsupials).
- feral animals Animals of domestic species that are not confined or under control (eg cats, horses, pigs).
- exotic fauna Nondomestic animal species that are not indigenous to Australia (eg foxes).

Zero susceptible stock premises (ZSP)

A premises that does not contain any susceptible animals or risk products, wastes or things.

Zoning

The process of defining, implementing and maintaining a disease-free or infected area in accordance with OIE guidelines, based on geopolitical and/or physical boundaries and surveillance, in order to facilitate disease control and/or trade.

Zoonosis

A disease of animals that can be transmitted to humans.

Abbreviations

AAHL	Australian Animal Health Laboratory
AI	avian influenza
APMV	avian paramyxovirus
AUSVETPLAN	Australian Veterinary Emergency Plan
CA	control area
CCEAD	Consultative Committee on Emergency Animal Diseases
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CVO	chief veterinary officer
DCP	dangerous contact premises
ELISA	enzyme-linked immunosorbent assay
IP	infected premises
ND	Newcastle disease
NMG	National Management Group
OIE	World Organisation for Animal Health
PCR	polymerase chain reaction
PCR ^P	polymerase chain reaction pathogenicity (test)
ppm	parts per million
RA	restricted area
RNA	ribonucleic acid
SOP	standard operating procedure
SP	suspect premises
SPF	specific pathogen free

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