

AUSTRALIAN VETERINARY EMERGENCY PLAN

AUSVETPLAN

Response strategy

Bovine brucellosis

Version 5.0

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.

National Biosecurity Committee

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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.

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Contents

1	Introduction	7
1.1	This manual	7
1.1.1	Purpose	7
1.1.2	Scope	7
1.1.3	Development	7
1.2	Other documentation	8
1.3	Training resources.....	8
2	Nature of the disease	9
2.1	Aetiology	9
2.2	Susceptible species	9
2.2.1	Zoonotic potential	9
2.3	World distribution	10
2.3.1	Distribution outside Australia.....	10
2.3.2	Occurrence in Australia	10
2.4	Epidemiology	10
2.4.1	Incubation period	10
2.4.2	Persistence of agent and modes of transmission.....	11
2.4.3	Factors influencing transmission	13
2.5	Diagnostic criteria.....	13
2.5.1	Clinical signs	13
2.5.2	Pathology	14
2.5.3	Differential diagnosis.....	15
2.5.4	Laboratory tests	15
2.5.5	Laboratory diagnosis	16
2.6	Resistance and immunity.....	18
2.7	Vaccination.....	19
2.8	Treatment of infected animals.....	20
3	Implications for Australia	21
3.1	Potential pathways of introduction.....	21
3.2	Social and economic effects	21
3.3	Critical factors for an Australian response.....	22
4	Policy and rationale	23
4.1	Introduction.....	23
4.1.1	Summary of policy	23
4.1.2	Cost-sharing arrangement.....	23
4.1.3	Governance.....	24
4.2	Public health implications	24
4.3	Control and eradication policy	24
4.3.1	Epidemiological assessment.....	24
4.3.2	Quarantine and movement controls.....	25
4.3.3	Tracing and surveillance	26
4.3.4	Zoning and compartmentalisation for international trade	27
4.3.5	Vaccination.....	27
4.3.6	Treatment of infected animals.....	28

4.3.7	Treatment of animal products and byproducts.....	28
4.3.8	Destruction of animals	29
4.3.9	Disposal of animals, and animal products and byproducts.....	30
4.3.10	Decontamination	30
4.3.11	Wild animal management.....	30
4.3.12	Vector management	31
4.3.13	Public awareness and media	31
4.3.14	Other strategies.....	31
4.4	Other control and eradication options.....	31
4.5	Funding and compensation.....	32
5	Guidelines for classifying declared areas and premises.....	33
5.1	Declared areas	33
5.1.1	Restricted area (RA).....	34
5.1.2	Control area (CA).....	34
5.2	Declared premises	34
5.2.1	Premises status classifications	34
5.3	Resolving premises and reclassifying declared areas	35
6	Movement controls.....	37
6.1	Principles	37
6.2	Guidelines for issuing permits.....	37
6.3	Types of permits.....	38
6.4	Recommended movement controls.....	40
7	Surveillance and proof of freedom	42
7.1	Surveillance	42
7.1.1	Specific considerations.....	42
7.2	Proof of freedom.....	42
Appendix 1	43
Appendix 2	44
Appendix 3	46
Glossary	49
	Standard AUSVETPLAN terms.....	49
Abbreviations	58
	Disease-specific abbreviations	58
	Standard AUSVETPLAN abbreviations	58
References	60

Tables

Table 2.1	Summary of survival times of <i>B. abortus</i> in the environment.....	11
Table 2.2	Diagnostic tests currently available in Australia for bovine brucellosis.....	18

1 Introduction

1.1 This manual

1.1.1 Purpose

This response strategy outlines the nationally agreed approach for the response to an incident – or suspected incident – of bovine brucellosis in Australia. It has been developed to guide decision making and so support the implementation of an efficient, effective and coherent response.

1.1.2 Scope

This response strategy covers bovine brucellosis caused by *Brucella abortus*.

This response strategy provides information about:

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

The key features of bovine brucellosis are described in the **bovine brucellosis Fact Sheet** (Section 0).

1.1.3 Development

The strategies in this document for the diagnosis and management of an outbreak of bovine brucellosis are based on risk assessment. They are informed by the recommendations in the World Organisation for Animal Health (OIE) *Terrestrial animal health code* (Chapter 8.4) and the OIE *Manual of diagnostic tests and vaccines for terrestrial animals* (Chapter 3.1.4). The strategies and policy guidelines are for emergency situations and are not applicable to policies for imported animals or animal products.

This manual has been produced in accordance with the procedures described in the **AUSVETPLAN Overview**, and in consultation with Australian national, state and territory governments; the relevant livestock industries; nongovernment agencies; and public health authorities, where relevant.

In this manual, text placed in square brackets [xxx] indicates that that aspect of the manual remains unresolved 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.

1.2 Other documentation

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

- other AUSVETPLAN documents, including the operational, enterprise and management manuals; and any relevant guidance and resource documents. The complete series of manuals is available on the Animal Health Australia website¹
- relevant nationally agreed standard operating procedures (NASOPs).² These procedures complement AUSVETPLAN and describe in detail specific actions undertaken during a response to an incident. NASOPs have been developed for use by jurisdictions during responses to emergency animal disease (EAD) incidents and emergencies
- relevant jurisdictional or industry policies, response plans, standard operating procedures and work instructions
- relevant Commonwealth and jurisdictional legislation and legal agreements (such as the Emergency Animal Disease Response Agreement – EADRA³), where applicable.

1.3 Training resources

EAD preparedness and response arrangements in Australia

The EAD Foundation Online course⁴ provides livestock producers, veterinarians, veterinary students, government personnel and emergency workers with foundation knowledge for further training in EAD preparedness and response in Australia.

¹ www.animalhealthaustralia.com.au/our-publications/ausvetplan-manuals-and-documents

² www.animalhealthaustralia.com.au/what-we-do/emergency-animal-disease/nationally-agreed-standard-operating-procedures

³ <https://animalhealthaustralia.com.au/what-we-do/emergency-animal-disease/ead-response-agreement>

⁴ www.animalhealthaustralia.com.au/emergency-animal-disease-training-program

2 Nature of the disease

Bovine brucellosis is a chronic infectious disease of cattle that causes abortions, the birth of weak or dead calves, infertility and, as a consequence, reduced milk production. All ages of cattle are susceptible, and infection can last for many years. In females, abortion is the major clinical sign, typically occurring between 5 and 7 months of gestation. After an abortion or following the birth of a weak or dead calf, it is common for the placenta to be retained and the uterus to become infected. Animals are most infectious at the time of an abortion or birth of a calf. Infected bulls develop infection and swelling of the testicles, and may become lame as a result of infected bursae.

2.1 Aetiology

Brucellosis in cattle is primarily caused by the bacterium *Brucella abortus*, which is one of six species of the genus *Brucella*. Nine biotypes have been identified, all of which are intracellular, parasitising, gram-negative, short rods. Brucellae have a wide host range, but cattle are the preferred host of *B. abortus*.

Other species of *Brucella* cause significant disease in domestic livestock. *B. ovis* causes significant reproductive disease in sheep. *B. suis* and *B. melitensis* cause serious disease in pigs and sheep/goats respectively. However, these species of *Brucella* are not readily transmitted from their preferred hosts to species other than humans; although cattle can become infected with these species, such infections are generally restricted to a single animal and are of minor epidemiological significance to bovine brucellosis.

Corbel (1997) noted that, in some areas in South America, *B. suis* has become established in cattle, which have subsequently become more important than pigs as a source of infection.

B. canis is associated with abortion and testicular infection in dogs, and has been recorded in many countries. Strains isolated from marine mammals form a separate group, designated *B. maris*.

2.2 Susceptible species

Infection with *B. abortus* has been recorded in most species of domestic livestock, as well as in dogs, cats and humans. However, these species have not been found to be significant in spreading the disease to cattle. Horses can become infected with *B. abortus*, but in this case the bacteria prefer bursae, tendons, muscles and joints, and are commonly found in cases of fistulous withers and poll-evil.

In the United States, there is a high prevalence in bison and other wild animals, but there are no documented cases of spread from these animals to farmed livestock.

2.2.1 Zoonotic potential

Brucella can infect humans and cause significant disease ('undulant fever'; see Section 2.5.1). The most important brucellosis disease in humans is ovine/caprine brucellosis caused by *B. melitensis* (Corbel 1997). However, *B. abortus*, *B. suis* and (rarely) *B. canis* are also human pathogens. *B. ovis* has not been

demonstrated to cause overt disease in humans; it is also not confirmed whether *B. maris* causes human disease.

2.3 World distribution

For the latest information on the distribution of bovine brucellosis, refer to the World Organisation for Animal Health (OIE) World Animal Health Information Database.⁵

2.3.1 Distribution outside Australia

Bovine brucellosis is present in the cattle population of most countries, especially in dairy cattle. The incidence varies enormously both within and between countries.

The highest incidence is observed in the Middle East, the Mediterranean region, sub-Saharan Africa, central and southwest Asia, China, India, Peru and Mexico (OIE 2020).

Advances in control and eradication practices have led to a significant reduction in incidence and to complete eradication in some countries, including several countries in western and northern Europe, Canada, Japan, Australia (1989) and New Zealand (1986) (OIE 2020).

2.3.2 Occurrence in Australia

Bovine brucellosis caused by *Brucella abortus* is not present in Australia.

B. melitensis, *B. suis* and *B. canis* are not present in domestic livestock in Australia, although *B. suis* occurs in feral pigs in Queensland and has, on rare occasions, involved domestic pigs. *B. suis* was isolated from cattle in a number of beef herds as part of the *B. abortus* eradication campaign in central Queensland. Cattle and feral pigs had a close association on the four properties involved (Cook & Noble 1984). Cow-to-cow transmission is thought not to occur. *B. ovis* is present in the sheep population; however, state accreditation schemes involving biosecurity standards and regular testing have reduced its influence.

2.4 Epidemiology

The most significant feature of the epidemiology of bovine brucellosis is the shedding of large numbers of organisms during the 10 days after abortion or calving of infected cows, and consequent contamination of the environment. Movement of infected cattle into a herd can result in transfer of the disease when cattle ingest the bacteria from aborted fetuses, placentas, and discharge from cows that have aborted or contaminated pasture or water.

2.4.1 Incubation period

The incubation period in an individual animal is influenced by sexual maturity, state of pregnancy at the time of infection (inversely proportional), size of the challenge dose and previous exposure to

⁵ www.oie.int/animal-health-in-the-world/the-world-animal-health-information-system/the-oie-data-system

infection or vaccination. For example, the average incubation period is 67 days for cows infected at 6 months of pregnancy. The minimum incubation period is about 1 month.

There is experimental evidence that localised foci of viable organisms remain in an unknown proportion of calves born of infected dams that have been serologically negative for considerable periods. There is a danger that such foci may break down at a later stage in life and cause active disease (Lapraik et al 1975).

In humans, the incubation period for the disease is 5–30 days or longer.

2.4.2 Persistence of agent and modes of transmission

General properties

Under ideal conditions, *B. abortus* can persist in organic materials such as faeces, abortion fluids and milk for up to 6 months. It may survive up to 8 months in an aborted fetus in the shade (Geering et al 1995). Table 2.1 summarises survival times of *B. abortus* in the environment. The bacteria are particularly susceptible to heat and desiccation, and direct sunlight will rapidly destroy exposed organisms. All standard disinfectants destroy *Brucella* spp.

Environment (including windborne spread)

In Australia, the persistence of the agent will be substantially influenced by geographic location and whether the herd is managed intensively or extensively.

Table 2.1 Summary of survival times of *B. abortus* in the environment

Medium	Temperature/environment	Viability
Sunlight	<31 °C	4.5 hours
Water	-4 °C	114 days
Water	Room	77 days
Soil	Room dried	<4 days
Soil	Cellar wet	66 days
Manure	Summer (Russia)	1 day
Liquid manure	Summer (Russia)	108 days
Manure	Winter (Russia)	53 days
Liquid manure	Winter (Russia)	174 days

Source: Adapted from Nicoletti (1980)

Live animals

Congenitally infected calves may be initially seropositive from colostral antibodies, may then become seronegative, and generally do not convert until they have calved or aborted, when organisms may be shed (Lapraik et al 1975). Infection may occur in cattle of all ages but persists most commonly in

sexually mature animals. Calves fed infected milk may excrete virulent brucellae in their faeces for several weeks.

B. abortus is usually transmitted by ingestion of contaminated feed or water, or by licking an infected placenta, calf or fetus, or the genitalia of an infected cow soon after it has aborted or calved. Inhalation and direct contact, especially with abraded skin or mucous membranes, may be a factor (Nicoletti 1980). Heifer calves infected in this manner may not be detected by serological testing and will be a source of infection after puberty.

Other species are not normally important to the persistence or transfer of *B. abortus*. However, transfer between horses and cattle grazing the same pasture was reported by Elliott and Christiansen (1977).

Transfer into a free population is primarily by importation of cows and heifers that are latently infected.

Infected cows

The large numbers of *B. abortus* shed by an infected cow at the time of calving or abortion are the main source of infection. An infected cow generally aborts once and then becomes a chronic carrier, intermittently excreting bacteria in the milk and reproductive secretions for many years. Chronically infected cows are known to excrete organisms each time they calve. However, cows generally spread much less infection at parturitions subsequent to an abortion.

Infected females may intermittently shed organisms in colostrum and milk. Faeces, urine and hygroma fluid may be involved, but are of minor importance. Genital discharges may continue to contain high numbers of organisms for several weeks following normal parturition or abortion. Congenital transfer from an infected cow to a fetus occurs infrequently.

Infected bulls

Bulls usually only become infected when there are abortions due to *B. abortus* in the herd. Once infected, the organisms tend to localise in the testes; large numbers may be excreted in the semen during the acute phase, making semen a potentially important source of infection. Bulls may also excrete *B. abortus* in faeces, urine and hygroma fluid.

Animal products

Milk and dairy products, including use as animal feed

Cows may excrete bacteria intermittently in milk (including colostrum) throughout lactation.

B. abortus is sensitive to pasteurisation temperatures. Yoghurt is presumed to be safe because of its low pH.

Semen and embryos from live susceptible animals

Natural service by a bull is unlikely to transfer infection. However, there is a real risk of transferring infection through artificial insemination, given the method used and the delivery point of semen in the reproductive tract of the dam (Manthei et al 1950). The risk of introducing the disease through embryos is negligible provided the embryos are properly handled between collection and transfer (IETS 1998).

Equipment, including personal items

Because of the fragility of the bacteria in the environment, fomites are not considered a likely source of infection.

Mechanical transfer from milking machines contaminated by infected milk is a possible, though unlikely, source of spread.

Generally, removal of infected animals from contaminated premises for 1 month is sufficient to prevent infection, provided the facilities have been sufficiently disinfected.

Arthropod vectors

Reservoirs of infection have been reported in a wide range of domestic animals, birds, and carnivores such as dogs. These animals may move infective material between properties; however, their role is limited. The transmission of brucellosis by ticks, fleas or mosquitoes from an infected herd to a noninfected herd has never been proved.

2.4.3 Factors influencing transmission

Given that environmental survival of the organism depends on favourable temperatures and low exposure to sunlight, winter conditions in the south of Australia favour survival. The concentrated husbandry of dairy herds and seasonal calving provide ideal conditions for transmission within a herd should an infected cow abort following introduction.

Many factors affect the epidemiology of bovine brucellosis. The most important are herd size and mobility, contiguity with infected herds, concentration of cattle and nature of production (dairy herds are more susceptible than beef cattle).

2.5 Diagnostic criteria

Suspicion of bovine brucellosis may be confirmed by serological and bacteriological investigation. A definitive diagnosis requires positive bacteriological identification of *B. abortus*. A presumptive diagnosis is made when there is significant serological evidence from several animals in a herd.

2.5.1 Clinical signs

Animals

Cattle

The primary clinical sign in female cattle is a significant number of late-term (5–7 months) abortions. In a population that has not been exposed to the disease before, these may appear as an ‘abortion storm’, with many cows aborting over a short period. Geering et al (1995) reported 30–80% abortions in fully susceptible herds. Many cases of endometritis and retained placentas also occur. However, such overt clinical evidence may not be seen in dry areas (where conditions are unfavourable for survival on pasture) or in large, extensively managed herds.

In bulls, clinical signs include inflammation of the testis (orchitis) and lameness due to bursitis, which is typically seen in infected bulls and occasionally in cows. Sexually immature cattle do not usually show any signs but may remain subclinically infected until maturity and pregnancy.

Other species

Little information is available on the clinical signs in domestic animals, including dogs and cats, and feral animals such as deer. However, eradication programs have been successfully completed without involvement of these species. In horses, *B. abortus* is commonly associated with chronic bursal enlargement, and with fistulous withers and poll-evil.

Humans

Brucellosis causes a significant disease in humans, called 'undulant fever' because it is associated with intermittent fever. Infection most commonly occurs during occupational contact with infected animals and their discharges, particularly at calving, but also during slaughtering if the uterus is broken. Infection can also occur by consumption of unpasteurised milk and dairy products from infected animals, by inhalation, through cuts and abrasions, or by droplet infection of the eyes. In endemic areas, veterinarians are particularly prone to brucellosis infection and are also at risk of exposure to organisms from live vaccines.

Acute brucellosis in humans usually begins with intermittent fever, weakness, chills, sweating, headaches, muscle and joint aches, and malaise. Human infections can also cause behavioural changes. Characteristically, the fever spikes each day, giving rise to the term 'undulant fever'. Undulant fever may be chronic and persist for many years.

2.5.2 Pathology

Gross lesions

Cows

In cows, the main sites of infection are the endometrium of the uterus and the fetal placenta. The uterus appears normal externally, but the endometrium is invariably infected. The intercotyledonary areas of the placenta are generally thickened with yellow gelatinised fluid and may be ulcerated, appear like leather and have mucoid or fibrinopurulent deposits on the surface. Placental cotyledons are hyperaemic, and may have areas of yellow-grey necrosis and be covered with a sticky brown exudate. When examined microscopically, the membranes and cotyledons contain many mononuclear cells with some neutrophils, and the chorionic epithelial cells are packed with the bacteria. An abnormally firm attachment of the chorionic villi of the placenta results from necrosis and enlargement of the maternal villi and the presence of inflammatory exudate.

Fetus

The fetus is usually swollen, with blood-tinged fluid found subcutaneously and in the body cavities; the umbilical cord may be thickened and swollen. The most important lesion is a catarrhal or fibrinous pneumonia. Microscopic examination of the lungs shows scattered foci of bronchitis and bronchopneumonia.

Bulls

B. abortus causes infection and swelling of the testicles that may not be obvious, but increasing pressure results in necrotic foci that grow and coalesce – this may lead to total testicular necrosis with

sequestration by inflammatory thickening of the tunica. *B. abortus* may also infect the accessory sex glands.

Brucellae in cattle may localise in the carpal and other bursae, where hygromas containing large numbers of bacteria may be found.

Pathogenesis

When brucellosis is introduced into a susceptible herd, it spreads easily because of the environmental contamination that occurs following an abortion. In cattle, infection with *B. abortus* is usually due to ingestion of infected material. The bacteria penetrate the mucosal epithelium of the gastrointestinal tract and are transported, either free or within phagocytic cells, to regional lymph nodes. If these bacteria do not remain localised or are not killed, they can spread to other organs, joints and bursae. This bacteraemic phase is subclinical and may take several weeks to some months. The bacteria then localise in the pregnant uterus and udder of cows, and the testicles and accessory sex glands of bulls.

In pregnant cows, the chorioallantoic membrane becomes inflamed and ulcerated, and bacteria can spread via the blood to the fetus and placenta. The preference of the bacteria for these sites is thought to be due to the presence of the sugar alcohol erythritol, which is a fetal product concentrated in the chorion, cotyledons and fetal fluids. In mature, nonpregnant cows, the bacterium localises in the udder.

Infection of the udder is often clinically inapparent, with no gross lesions. Brucellae localise and replicate primarily in macrophages in mammary secretions or in phagocytes; they form an important source of organisms for periodic reinfection (and potentially for infection of calves and humans via the milk). Hence, if the cow later becomes pregnant, the uterus can become infected during a subsequent bacteraemic phase.

2.5.3 Differential diagnosis

There are many potential causes of abortion in cattle. Endemic infectious causes of abortion include viral diseases such as infectious bovine rhinotracheitis and mucosal disease; and infections with other organisms such as *Trichomonas foetus*, *Neospora caninum*, *Campylobacter fetus*, *Listeria monocytogenes*, *Sarcosporidia*, various *Leptospira* species and fungi. Exotic viral diseases causing abortion include Rift Valley fever and Wesselsbron disease (in sheep). There are also a range of potential noninfectious causes resulting from nutritional and toxic factors.

Generally, bovine brucellosis can be differentiated from these conditions by its pathology, its presentation and use of the excellent range of laboratory diagnostic methods.

2.5.4 Laboratory tests

Samples required

Specimens of milk from each quarter of the udder; whole aborted fetuses; fetal membrane cotyledons; or spleen, lung and stomach contents should be hygienically collected from each animal that aborts (Geering et al 1995). Vaginal swabs collected in the 6-week period following calving or abortion may also be useful. Blood samples for serum should be collected from all animals that have recently calved or aborted.

Where suspect cows are slaughtered, various lymph nodes, including the mammary lymph nodes; samples of spleen, mammary gland, uterine tissues and fluids; and blood for serum, are valuable diagnostic materials. In mature cows, about 90% of infections can be detected by culture of the mammary lymph nodes; the inclusion of samples of mandibular and medial iliac lymph nodes and the uterine caruncles (if present) will increase the chance of successful culture to almost 100%. In heifers, additional tissues, including the spleen, will be needed to obtain meaningful results (see Appendix 2 for details).

Transport of specimens

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

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

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

Packing specimens for transport

Samples must be individually labelled so that they can be related to each animal tested. Care must be taken to protect samples from extremes of heat during collection, storage and transport to the laboratory.

2.5.5 Laboratory diagnosis

Diagnostic tests for brucellosis can be classified into those that identify the organism, those that demonstrate specific immunoglobulins and those that demonstrate a specific allergic response. Laboratory diagnosis of brucellosis can generally be made by the state or territory veterinary diagnostic laboratory.

Bacteriology

Initial bacterial culture can be carried out at the state or territory laboratory, but samples of isolates should be sent to the National Brucellosis Reference Laboratory at CSIRO-ACDP for confirmation.

In the past, cultural examination for the diagnosis of bovine brucellosis was considered unreliable. Often, there are only small numbers of bacteria in the tissues, and it has been difficult to obtain uncontaminated specimens. Primary isolation may take up to 8 days. Accurate identification of brucellae and their biotypes is important, as this may assist in determining the host range and potential reservoirs of infection. No test can identify an organism as belonging to the genus *Brucella*, but a combination of serological and bacteriological methods usually enables an organism to be correctly classified.

Serology

In Australia, detection of immunoglobulins is based on the Rose Bengal plate test (RBPT), complement fixation test (CFT) and enzyme-linked immunosorbent assay (ELISA) on serum, and the milk ring test (MRT) on milk. Results must be tested and interpreted to the standard defined in *Australian standard diagnostic techniques for animal diseases* (Corner & Bagust 1993). Two ELISAs are mentioned in the *OIE Manual of diagnostic tests and vaccines for terrestrial animals*: an indirect ELISA specific for IgG1, and a competitive (inhibition) ELISA using monoclonal antibodies. The value of ELISA testing is that it is relatively unaffected by the condition and age of the blood samples, and should minimise the need to resample cattle whose serum samples are unsuitable for testing by the CFT. Nicoletti (1992) reported the problem of false positives with the CFT when sampling infected water buffalo cows.

Nielsen et al (1995) and Uzal et al (1996) evaluated an improved competitive ELISA and reported that it had a specificity greater than 99.6% on a negative population and a sensitivity of 100% for infected animals. They concluded that the new test was easy to perform and useful in areas of low prevalence.

The Animal and Plant Health Inspection Service of the United States Department of Agriculture has also reported a new serological test for detection of *Brucella* antibodies. Termed the rapid automatic presumptive (RAP) test, it uses a computer reader and recorder device to assess and report test results. This minimises subjectivity and has increased laboratory-to-laboratory uniformity.

Cross-reactions to other organisms may cause some diagnostic problems. Several authors have reported serological reactions to the presence of *Yersinia enterocolitica*. In New Zealand, 35% of deer in a large export consignment reacted to the *Brucella abortus* serum agglutination test (SAT). This reaction was later considered to have been caused by previous exposure to *Yersinia enterocolitica* (Hilbink et al 1995).

Other tests

The MRT performed on bulk milk samples is effective for screening and monitoring dairy cattle for brucellosis, but is less reliable in large herds. An alternative immunological test is the brucellin skin test, which can be used for screening unvaccinated herds, including beef cattle, provided that a purified, standardised antigen preparation is used.

CSIRO-ACDP tests

The diagnostic tests currently available in Australia are shown in Table 2.2.

Table 2.2 Diagnostic tests currently available in Australia for bovine brucellosis

Test	Specimen required	Test detects	Time taken to obtain result
Culture and identification of <i>B. abortus</i>	Tissue	Brucellae	6 days
Rose Bengal plate test	Serum	Antibody	10 minutes
Complement fixation test	Serum	Antibody	4 hours
Enzyme-linked immunosorbent assay	Serum	Antibody	2 hours
Serum agglutination test	Serum	Antibody	24 hours
Bulk milk ring test	Milk	Antibody	1 hour
Individual milk ring test	Milk	Antibody	1 hour

Note: Testing resources are available at a number of veterinary laboratories in Australia.

2.6 Resistance and immunity

Establishment of infection by *Brucella* spp. depends on the number and virulence of organisms, and the relative resistance of the host animal, as determined by innate and acquired immune mechanisms. Sexually mature cows, pregnant heifers and bulls are the most susceptible to infection with *B. abortus*. A small proportion of crossbred cattle appear to be innately resistant, as a result of the ability of macrophages to limit the replication of *B. abortus*. This innate resistance is inherited as a dominant trait.

Sexually immature cattle are quite resistant to exposure to *B. abortus*; susceptibility increases with sexual development and pregnancy. Calves may acquire infections in utero or by ingestion of contaminated milk (Nicoletti 1980). Usually, calves show only a transient antibody response after exposure. However, they may continue to excrete organisms for several weeks after milk feeding has ceased. A small but important percentage of heifer calves that are infected in early life and are negative to serological tests abort or have an infected calving during the first pregnancy (Cunningham 1977). There is a tendency for males to become infected at a younger age than females; they may acquire infection during calthood and retain it into adult life (Rankin 1965).

The rate of production of antibody depends on the type of stimulus received. The immunoglobulins produced following natural infection are different from those produced following vaccination; this difference is used to discriminate between them. It is generally agreed that cell-mediated responses are the dominant immune response to bovine brucellosis, and that dermal hypersensitivity and lymphocyte stimulation are poor indices. The cell-mediated response generally appears at least 1 week before the appearance of agglutinating antibodies. Because the bacterium is an intracellular, facultative organism, attenuated ('live') vaccines have been far more successful than inactivated vaccines.

2.7 Vaccination

Effective vaccines have played an important role in reducing the incidence of brucellosis in many countries.

Strain 19

The most widely used vaccine for the prevention of brucellosis in cattle is prepared from *B. abortus* strain 19. It is an attenuated ('live') vaccine and is normally given to female calves aged 3–6 months as a single subcutaneous dose of $5-8 \times 10^{10}$ viable organisms. A disadvantage of strain 19 is that it causes vaccinated animals to produce antibodies that, using standard diagnostic tests, are indistinguishable from the antibodies produced by animals infected with *Brucella*.

A reduced dose of 3×10^8 to 3×10^9 organisms can be administered to beef or dairy cattle aged 4–12 months, but 5–10% of the animals will develop persistent antibody titres (Beckett & MacDiarmid 1985). Alternatively, the vaccine can be administered to cattle of any age as two doses of $5-10 \times 10^9$ viable organisms given by the conjunctival route; this produces protection without a persistent antibody response (OIE Terrestrial Manual).

Strain 19 is of low virulence for cattle. Subcutaneous vaccination of pregnant cattle can cause abortions, but this is rare, occurring in less than 1–2.5% of animals under field conditions (Beckett & MacDiarmid 1985).

B. abortus strain 19 vaccine induces good immunity to moderate challenge by virulent organisms. Each batch must be checked for purity, viability, smoothness and absence of toxicity or virulence.

The United States Centers for Disease Control and Prevention recommends concomitant regimens of doxycycline and rifampin for human post-exposure prophylaxis against the strain 19 vaccine.

Strain 45/20

B. abortus strain 45/20 vaccine is prepared by suspending inactivated cells in an oil adjuvant. It is normally administered as two doses, given 6–12 weeks apart, followed by an annual booster. The degree of protective immunity conferred by strain 45/20 vaccine is probably less than that conferred by strain 19 vaccine. Batch variation in immunogenicity and a tendency to stimulate antibodies reactive with *Brucella* antigens can be major problems.⁶ In most countries where herd vaccination appears to be useful, reduced doses of strain 19 are now used instead of strain 45/20 vaccine (OIE Terrestrial Manual).

Strain RB51

The RB51 vaccine strain is an attenuated, genetically stable, rough morphology mutant of *B. abortus* that was approved for use in the United States in 1996. Vaccination with RB51 does not result in measurable antibody titres to *B. abortus* using standard diagnostic tests. This is an important feature for use in efforts to eradicate brucellosis in domestic cattle, and replacing strain 19 vaccine with the RB51 vaccine eliminates costs associated with the retesting and trace-backs of false positive reactors.

United States data indicate that RB51 is protective at doses comparable to those used for strain 19 when given to calves at 3–10 months of age. RB51 can infect the placenta and uterus in the pregnant animal. Unpublished reports by the vaccine manufacturers in the United States indicate that vaccination with a reduced dose (1×10^9) of strain RB51 can lead to abortion in 0.5% of vaccinated animals.

⁶ During the Australian eradication campaign, the use of 45/20 vaccine did interfere with diagnostic tests.

Detection of possible human infection with the RB51 vaccine strain and development of recommendations for chemoprophylaxis are complicated by two characteristics of the new vaccine strain. First, an immune response to the RB51 strain is not detected on routinely available serological tests. An experimental dot-blot assay used for serological measurement of RB51 postvaccination titres has been evaluated under experimental and field conditions in cattle, but this assay has not been validated using human serum. Second, RB51 was derived by selection in rifampin-enriched media and is resistant to rifampin in vitro.

Veterinarians and other animal healthcare personnel should be made aware of the possible risk of infection associated with the veterinary use of RB51, although evidence of serious disease for humans with a normal immune system has not been officially documented (CDC 1998).

***B. suis* biovar 1 strain 2**

Since 1971, a smooth strain of *B. suis* biovar 1 strain 2 has been used as an oral vaccine to control brucellosis in cattle, sheep, goats and pigs in China. This vaccine protects cattle against *B. abortus*, is safe if administered orally, and does not induce persistent antibody titres.

For further details, see Section 4.3.5.

2.8 Treatment of infected animals

Several chemotherapeutic agents have been employed in recent decades for the treatment of *Brucella abortus* infection in cows; however, none of these has been entirely successful. Radwan et al (1993) identified two therapeutic regimens that were effective in eliminating brucellae from naturally infected cows. Each involved repeat treatments with long-acting oxytetracycline and streptomycin administered by intramuscular injection and intramammary infusion for up to 6 weeks. Before treatment commenced, all cows were dried off. For a number of reasons (expense, withholding periods after treatment, development of antibiotic resistance, proof of success), such treatments are impracticable as part of an eradication program in Australia.

3 Implications for Australia

3.1 Potential pathways of introduction

The greatest risk for entry of bovine brucellosis into Australia is through cattle imported from countries with endemic infection. With current import requirements, this method of introduction is unlikely.

The risk from imported semen is minimised by effective import controls.

3.2 Social and economic effects

Social and economic effects are likely to be felt primarily by the owners of affected herds. Infection with *B. abortus* can have severe effects on production, including the loss of calves, interference with seasonal calving, infertility, decreased milk production, weak calves, joint infections and increased culling of nonproductive cows.

Quarantine of infected herds immediately restricts an owner's options for selling cattle, especially breeding stock, and studs are therefore severely affected. The index infected premises, and any other infected or suspect properties that may be depopulated, will be severely affected by the immediate stoppage of productive operations and loss of income.

These effects can be reduced by prompt action to remove affected stock, and implement hygiene and disinfection measures, thus enabling restocking at the earliest opportunity.

Neighbouring producers and those subject to investigation as a result of tracing will also suffer disruption to their operations. Generally, this will not be severe – it will be restricted to farm survey, discussion, and potentially the testing of all breeding cattle on the property, or at least those at risk.

Declaration of a restricted area would affect a wider group of producers, especially producers of stud cattle who will be prevented from selling cattle until the distribution of the disease is clarified. Prevention of cattle markets within an area would have minimal direct effects. Where the disease is restricted to a small number of properties and a depopulation strategy is adopted, the economic effects will be minimised.

The presence of brucellosis in Australia is unlikely to affect beef exports even to countries free from the disease. Of the major importers of Australian beef, Japan, South Korea and the United States all have bovine brucellosis. However, trade of Australian breeding cattle to countries free from brucellosis may be temporarily affected. There is potential for a decrease in domestic consumption of beef, at least in the short term.

Zoning would potentially interrupt the free movement of breeding stock and the movement of cattle to slaughter at preferred markets. The effects are likely to be minimal, especially where a protocol for serological testing to enable movements is implemented.

3.3 Critical factors for an Australian response

- Bovine brucellosis was eradicated in Australia after many years of control and eradication effort, so the social, economic and political impacts of a fresh outbreak would be great.
- Many other countries have also eradicated brucellosis. In each case, the infection was so widespread that a long period of vaccination was necessary to reduce the incidence to a level at which eradication by test and slaughter was feasible. However, vaccination alone has never achieved eradication.
- In a naive population, the infection is likely to spread rapidly unless detected early.
- In a dairy herd, abortions would give an early indication that infection had occurred, and the extent of an outbreak could be limited. However, in extensively farmed beef herds, the disease may remain undetected because of the lack of close observation and may not be detected until it spreads to more intensively managed properties. In either case, spread to further herds from cattle movements is unlikely until the first abortion occurs.

Brucellosis can be eradicated in two principal ways:

- stamping out all exposed cattle
- serological testing and slaughter of animals showing a positive reaction.

In either case, it is important to promptly remove all infected and suspicious animals from a confirmed infected herd to reduce the opportunity for further spread.

4 Policy and rationale

4.1 Introduction

Bovine brucellosis is a World Organisation for Animal Health (OIE)-listed disease that has the potential for rapid spread within a herd and may spread to other herds. It is important in the trade of cattle and is a significant public health issue. It is difficult to recommend a single strategy for the eradication of bovine brucellosis for Australia that will be practical for all circumstances or locations,

4.1.1 Summary of policy

The overall policy is to eradicate brucellosis by:

- *destocking*, which involves quarantine, slaughter of all infected and exposed susceptible animals and sanitary disposal of destroyed animals – if only a small number of properties are involved
- *test and slaughter*, which involves regular serological testing of suspect animals and slaughter of those that test positive – if brucellosis has spread more widely.

These strategies will be supported by:

- *quarantine and movement controls* on animals on infected premises (IPs) and suspect premises (SPs) to prevent the spread of infection
- *tracing and surveillance* to determine the source and extent of infection, and to provide proof of freedom from the disease
- *vaccination*, which should be considered for assisting in the eradication of the disease if a major outbreak occurs in Australia or if particular situations warrant
- *zoning* to define infected and disease-free areas
- *a public awareness campaign* to facilitate cooperation from industry.

An uncontrolled outbreak of brucellosis would cause severe production losses to the affected producers, with potential dislocation and financial losses to the cattle industry from effects on exports. There is potential for human disease, and work health and safety measures must be adopted.

4.1.2 Cost-sharing arrangement

In Australia, bovine brucellosis is included as a Category 2 emergency animal disease in the Government and Livestock Industry Cost Sharing Deed in Respect of Emergency Animal Disease Responses (EAD Response Agreement – EADRA).⁷ When cost sharing of the eligible response costs of an incident is agreed, Category 2 diseases are those for which costs will be shared 80% by government and 20% by industry.

⁷ Information about the EAD Response Agreement can be found at www.animalhealthaustralia.com.au/what-we-do/emergency-animal-disease/ead-response-agreement.

4.1.3 Governance

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

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

4.2 Public health implications

Brucellosis is a significant zoonosis, and health authorities must be alerted to the potential for human infection.

The only risk to the general public is from consumption of unpasteurised milk from infected cows.

People handling infective material (including vaccines) must be advised of appropriate work health and safety requirements.

4.3 Control and eradication policy

The strategy is to use partial destocking as the primary option for eradication. However, test and slaughter (see Section 4.3.8) is an alternative option that can be used if the disease has spread widely beyond the index property, if a herd infection is found to be recent, or if suspect animals are of high value or large in number and compensation costs must be limited. A combination of the two strategies is likely to be warranted.

Prompt implementation of individual property quarantine will reduce the potential for spread between farms by cattle movements. Effective tracing of the disease is the key to rapid resolution of an outbreak. Surveillance will determine the distribution of the disease and the herd prevalence, allowing the best strategy to be selected.

The approach adopted should be thoroughly discussed with the industry and individual producers to ensure maximum cooperation in the implementation of the agreed strategies.

4.3.1 Epidemiological assessment

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

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

- the spatial distribution of infected and free animal populations
- the source of infection
- the prevalence of infection
- pathways of spread and the likely size of the outbreak
- risk factors for the presence of infection and susceptibility to disease (including weather and insect populations).

Epidemiological assessment, and tracing and surveillance activities (see Section 4.3.3) in an EAD response are interrelated activities. Early findings from tracing and surveillance will be inputs into

the initial epidemiological assessment (eg considering spatial distribution of infection). The outcomes of the initial epidemiological assessment will then guide decisions on subsequent tracing and surveillance priorities.

The outcomes of the epidemiological assessment will also be used to guide the selection of other appropriate response measures (including the application of movement controls) and assess the progress of disease control measures.

Ongoing epidemiological assessment is important for any EAD response to aid evaluation of the continued effectiveness and value of response measures. Ongoing epidemiological assessment will consider the outcomes of tracing and surveillance activities, and will contribute evidence to support any later claims of disease freedom.

4.3.2 Quarantine and movement controls

Quarantine and movement controls will be imposed on IPs, SPs and dangerous contact premises (DCPs) that are identified through tracing and surveillance (see Section 5).

Declaration of a restricted area (RA) or control area (CA) that includes contiguous properties is unlikely to assist disease control but could be used to provide additional reassurance during the period of initial investigation.

People and vehicles will not be subject to any restriction.

See Section 5 and Section 6 for further details on quarantine and movement controls, respectively.

Quarantine

Where there is any suspicion of bovine brucellosis, quarantine must be imposed immediately to ensure that any infection is contained. Quarantine may be partial or total, depending on the extent of infection and herd management. For example, on very large properties or where valuable stud animals are involved, a group of infected or suspicious animals that are isolated from the rest of a herd may be quarantined and managed separately. However, all animals in such herds will require repeated serosurveillance to confirm their freedom from infection.

Movement controls

Prompt examination of movement records will assist in tracing any movements that may be suspect. Movement of latently infected cows and heifers presents the greatest risk, but the potential for movement of infected material by dogs or birds cannot be ignored. Strict sanitation measures must be applied immediately to isolate animals likely to calve; the area surrounding an abortion or calving area must be disinfected; and effective fencing is required.

Susceptible cattle on quarantined properties may only be moved directly to an abattoir for slaughter. Where isolation of animals from an infected group is confirmed to the satisfaction of the chief veterinary officer (CVO), such animals may be moved off the property after two negative tests at a minimum interval of 60 days.

Zoning

Zoning (see Section 4.3.4) may help to define the extent of the disease and enable better controls over the movement of live animals and products. However, zoning is only likely to offer a trade advantage for international markets where countries have specific import requirements. The worth of these

markets must be balanced against the cost to domestic trade. There is no justification for states to impose special conditions based on state boundaries.

4.3.3 Tracing and surveillance

Tracing all cattle movements involving the IP will be undertaken as a matter of priority. Adjacent properties will also be investigated and the cattle serologically tested.

Serosurveillance also needs to be undertaken on all premises that have provided or received breeding cattle from the IP.

Targeted monitoring and surveillance in the form of milk ring tests and examination of abortions should be carried out. There should also be targeted serological monitoring in designated abattoirs.

If premises have been depopulated, they can be restocked with disease-free cattle after a period of freedom from all susceptible species. Depending on the environmental conditions, this period may be a minimum of 30 days after depopulation and decontamination. Surveillance of the new herd should be maintained until 30 days after calving, with serological testing of all breeding animals at the end of this period.

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

Tracing

When infection is suspected or confirmed, trace-back and trace-forward of cattle movements is essential to identify the index case and other potentially infected herds. Movements of other domestic animals and wild animals are of secondary importance. Trace-back should extend to all herds where an infected animal has been for any period of its life. Trace-forward of all movements off the property must commence with the most recent movements, moving back in time according to the results of trace-back. Tolson and Jervois (1990) reported that the source of infection was not determined in 18% of Australian herds found to be infected in the period 1984–89.

Surveillance

The purpose of surveillance is to identify any infected herds not already identified by tracing and investigation of neighbouring properties. It provides assurance that the infection has not spread to other herds in the immediate area. Additional surveillance may be needed to assist the design and implementation of the control strategy. Surveillance for evidence of antibodies to *B. abortus* by milk ring testing of dairy factories and serological testing of high-risk herds is the preferred approach. On-farm activities also include examination of production records for evidence of abortions and/or infertility. Reports of abortions should be investigated.

As cattle movements are the most likely means of disease spread, special attention should be given to herds selling breeding animals and those with a history of recent introductions. Closed herds are unlikely to introduce *B. abortus*, and breeding stock from such herds is unlikely to spread the disease.

Routine surveillance is usually based on the use of cheap screening tests such as the Rose Bengal plate test. This is then followed by the complement fixation test and ELISA to confirm infection. The bulk milk ring test (MRT) is a very effective screening tool in dairy herds and is cheap, easily carried out and effective in identifying infected herds even where the within-herd prevalence is very low. However, the bulk MRT does not detect infected heifers, recently aborted cows or the presence of a few reactors in a large herd (see Section 2.5.5 for further information on these tests).

The brucellin skin test has been used in several countries. In New Zealand, it has been found to be cheap and reliable for defining the size and distribution of a brucellosis outbreak and for post-eradication surveillance. The cost was estimated to be approximately 60% of that of on-farm serological testing (MacDiarmid & Hellstrom 1988).

4.3.4 Zoning and compartmentalisation for international trade

Where it is not possible to establish and maintain disease freedom for the entire country, establishing and maintaining disease-free subpopulations, through zoning and/or compartmentalisation,⁸ may be considered.

In the case of a limited disease outbreak, a containment zone⁹ may be established around the areas where the outbreak is occurring, with the purpose of maintaining the disease-free status of the rest of the country outside the containment zone.

All zoning applications would need to be prepared by the Australian Government in conjunction with the relevant jurisdiction(s) and agreed to by the CCEAD. Compartmentalisation applications would require input from the relevant industries. Recognition of both zones and compartments must be negotiated between the Australian Government and individual overseas trading partners. Zoning and compartmentalisation would require considerable resources that could otherwise be used to control an outbreak. Careful consideration will need to be given to prioritising these activities, because the resulting competition for resources could delay the quick eradication of the disease and recognition of disease freedom.

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

General guidelines for zoning and compartmentalisation are in Chapter 4.4 of the OIE *Terrestrial animal health code*.

4.3.5 Vaccination

Effective vaccines against brucellosis are available, and their use should be given serious consideration. Attenuated (live) vaccines such as strain 19 have generally provided better protection than inactivated vaccines (eg strain 45/20). Strain 19 effectively controls abortions in a cattle population but does not totally prevent the spread of infection. It has the disadvantage of stimulating the production of IgG1 antibodies that can persist into adulthood and interfere with serological

⁸ With zoning, disease-free subpopulations are defined primarily on a geographical basis. With compartmentalisation, disease-free subpopulations are defined primarily by management practices (such as the biosecurity plan and surveillance practices of enterprises or groups of enterprises).

⁹ The OIE defines a 'containment zone' as an infected zone within a previously free country or zone, which includes all suspected or confirmed cases that are epidemiologically linked and where movement control, biosecurity and sanitary measures are applied to prevent the spread of, and to eradicate, the infection or infestation. The Australian Government Department of Agriculture and Water Resources commissioned a report on what would be required for the establishment of containment zones in Australia. This report is available at www.ausvet.com.au/tools-resources.

testing. It is thus usually suitable only as a precursor to eradication and to reduce economic damage where there is a high prevalence of brucellosis.

In February 1996, a new attenuated vaccine, strain RB51, was licensed by the Animal and Plant Health Inspection Service of the United States Department of Agriculture for use in cattle in the United States. This vaccine does not stimulate the production of antibodies detectable in standard diagnostic tests but does stimulate production of other antibodies that can be detected with a special assay and indicate that the animal has been vaccinated. Strain RB51 has been reported to be as effective as strain 19. Vaccinated animals need to be permanently identified.

Strain 19 is still the vaccine of choice for Australia. The use of live vaccines must address the potential danger to humans. Strain 19 is potentially virulent to humans. *B. abortus* RB51 infection in humans is possible but has not been documented.

Because strain 19 and strain RB51 are live bacteria, vaccine packs should be kept cool, and away from sunlight and chemicals during storage and handling; they should be used as soon as possible when opened.

Criteria to be used in making decisions on vaccination include:

- interval from incursion to detection
- nature of enterprises affected
- number of herds or cattle affected
- analysis of the costs and benefits of vaccination and test and slaughter, compared with a slaughter policy
- ability to effectively zone vaccination areas
- public health risks to those handling infected stock
- need for permanent identification of vaccinates.

4.3.6 Treatment of infected animals

For various reasons (see Section 2.8), treatment with antibiotics is not normally used in bovine brucellosis eradication programs.

4.3.7 Treatment of animal products and byproducts

Confirmed infected cows that are close to calving or have a vaginal discharge must not be sent to slaughter, because there is a risk of human infection. Such animals must be handled with care and destroyed on the property. *B. abortus* is readily destroyed by heat, and infected carcasses and parts can be safely rendered.

Unpasteurised milk from infected cows must not be used for human consumption.

No special processing is required for meat produced from cattle depopulated as part of brucellosis eradication. Precautions should be taken in the handling and disposal of the placenta, uterus and mammary gland from suspect cattle on farms, abattoirs and animal byproduct establishments.

Standard rendering techniques effectively inactivate any organisms.

4.3.8 Destruction of animals

Depopulation

Unlike a test-and-slaughter strategy, depopulation has the advantages of being quick and allowing the country to be declared free without undue delay. Depopulation will therefore be used immediately if the disease is restricted to a few herds, if the herds are small, and if the disease is contained and unlikely to spread. The slaughtered animals will be disposed of by the most appropriate means for each situation.

Test and slaughter

In a test-and-slaughter strategy, all cattle over the age of 6 months are repeatedly tested using agreed serological tests. All animals reacting positively to such a test are destroyed or consigned for immediate slaughter at an approved abattoir, and tissues are submitted for culture of *B. abortus*. Because of latent infection in young animals, all calves of reactor cows are also culled from the herd.

Herds should be retested at regular intervals (30–60 days) until two clean no-reactor tests have been achieved. Further surveillance tests are done 6 months and 12 months after the clean test (taking into account the herd calving pattern). Before quarantine is lifted, all breeding females must have calved and tested negative at least 30 days after calving. Additional surveillance testing may be required. Animals should be permanently identified. Mingling of animals of different age groups should be minimised.

Eradication by test and slaughter is not always successful. Problems occur for about 5% of herds, often due to latently infected calves that remain serologically negative to standard tests until late into their first pregnancy. Any indication of a problem (ie the disease spreading more quickly than the instituted eradication measures) should therefore be treated severely, by cattle depopulation or a vaccination program.

Stamping out

The most reliable way to eradicate *B. abortus* is through quarantine of IPs and DCPs, and destruction of all susceptible cattle, including juveniles, on IPs (and probably on DCPs, according to circumstances). Under such a policy, live cattle would only be permitted to move from IPs or DCPs for slaughter at an approved abattoir. The property should remain free of susceptible animals and under quarantine until freedom from environmental contamination is assured.

DCPs are properties that adjoin IPs, as well as those identified by tracing (see Section 5). Once potentially infected cattle are removed from these premises, and there is no clinical or serological evidence of disease, they should continue to be monitored for evidence of brucellosis by milk or serological testing.

Depopulation has serious economic effects. The availability of compensation is an important incentive to ensure that owners promptly report any evidence of infection.

Confirmed infected cows that are close to calving or have a vaginal discharge pose a disease risk to personnel; they are preferably destroyed and disposed of on the property. Care is required to ensure that burning and burial comply with local requirements. Where such cattle must be removed from the property for disposal, they should be destroyed and then transported in leakproof vehicles to the place of disposal.

Reactor animals can be sent to abattoirs for slaughter, but this may involve a risk to employees (see Section 4.3.9) and approval by the CVO is required. Abattoirs must be advised of the date of arrival of

reactors before they are dispatched, and supervision of the slaughter is mandatory. Reactor cattle must be permanently identified and must be transported in isolation from other animals; cleaning of vehicles after unloading is required.

Destruction of animals other than cattle is generally unnecessary. Infected horses are not usually contagious and should be isolated from any contact with cattle. Euthanasia of infected horses may be negotiated with the owner on humane and/or human health grounds. Destruction of property is unnecessary, as *B. abortus* is susceptible to sunlight, high temperature, cleaning and disinfection.

See the **AUSVETPLAN operational manual *Destruction of animals*** for appropriate methods for destruction of cattle.

4.3.9 Disposal of animals, and animal products and byproducts

Hygienic measures should include the disposal of aborted fetuses and membranes, removal and disposal of infected animals, and disinfection of areas contaminated by aborted fetuses and membranes. Strict personal hygiene precautions must be applied when handling potentially infective materials.

Care must be taken during disposal to ensure that infected fluids and tissues do not come into contact with humans or other animals. Cattle carcasses may also be rendered (see the **AUSVETPLAN operational manual *Disposal***).

4.3.10 Decontamination

Decontamination has little role in eradication if destocking is employed. After a property is destocked and decontaminated (to eliminate any moist organic areas), it should be spelled for a minimum of 30 days.

B. abortus is susceptible to sunlight, high temperatures and a range of chemicals, including 0.03% formalin, 1% phenol, 0.01% beta propiolactone, sodium hypochlorite, sodium hydroxide, iodines, quaternary ammonium compounds, ether and chloroform (see the **AUSVETPLAN operational manual *Decontamination***).

Other measures to reduce the likelihood of environmental survival of infective bacteria include draining wet areas and ploughing to improve the rate of desiccation.

The spread of infection can be minimised by cleaning and disinfecting vehicles used to transport infected cattle.

4.3.11 Wild animal management

Feral animals, including cattle, buffalo and deer, may become infected with brucellosis; if they graze the same area as domesticated stock, they should be controlled by mustering or field destruction.

The disease will be less likely to spread if contaminated areas are cleaned up promptly, the integrity of perimeter fences is ensured, and access to potentially heavily contaminated areas such as dairy effluent disposal sites and carcass burial or disposal sites is prevented.

4.3.12 Vector management

Mechanical transfer of *B. abortus* by feral livestock, foxes, dogs, cats and birds is theoretically possible, but their role is considered unimportant.

Despite the ability of flies and ticks to experimentally transfer infection, their role in spreading *B. abortus* from infected to uninfected herds has not been established.

4.3.13 Public awareness and media

Because brucellosis is a significant zoonosis, all people handling infective material, including live vaccines, should wear protective glasses, gloves and clothing, and protect skin breaks from infection. There is no risk to the general public except from unpasteurised milk (see Section 2.4.2). Vaccine strains may cause human disease, although transmission of infection to humans through milk has not been recorded with strain 19. The RB51 vaccine strain is of concern (see Section 2.7).

A media campaign must emphasise the importance of cattle producers inspecting susceptible animals regularly and reporting abortions, the birth of weak or dead calves, or infertility. An abortion investigation program that relieves producers of the costs of investigation is a useful strategy. Details of any imposed movement controls need to be readily available and clearly explained to industry.

Given the important zoonotic implications, people at risk must be advised of appropriate work health and safety requirements, and health authorities must be alerted to the potential for human infection.

4.3.14 Other strategies

B. abortus is rapidly inactivated by desiccation and sunlight. Properties that have been depopulated in summer can normally be restocked 30 days after the completion of decontamination, with minimal risk of reinfection. However, if depopulation occurs during winter in southern Australia, an additional period may be required. The replacement herd should be tested (see Section 7 for further details).

4.4 Other control and eradication options

Bovine brucellosis was endemic in Australia before 1989 and was eradicated. There is no reason why a new incursion could not also be eradicated. Many other countries have also controlled and then eradicated bovine brucellosis. The extent of the task and how long it might take will depend on the location and circumstances at the time. In a prolonged eradication program, the previously developed Standard Rules and Definitions may need to be reintroduced.

Strategy if the disease becomes established

Despite the high costs of disease eradication strategies, such as depopulation/repopulation and test and slaughter, it is unlikely that, given the effort to originally achieve disease-free status for bovine brucellosis, the Australian cattle industry, state and territory governments or the Australian Government would allow this disease to become re-established.

The primary strategy would be to define the prevalence and distribution of the disease so that the two eradication strategies could be logically applied to remove infection from the population as quickly as possible. The use of vaccine may be warranted where intractable infection is found in many large or

valuable herds and where such use does not compromise the proposed timetable for achieving eradication.

4.5 Funding and compensation

Details of the cost-sharing arrangements can be found in the Government and Livestock Industry Cost Sharing Deed in Respect of Emergency Animal Disease Responses.¹⁰ Details of the approach to the valuation of, and compensation for, livestock and property in disease responses can be found in the **AUSVETPLAN operational manual *Valuation and compensation***.

¹⁰ www.animalhealthaustralia.com.au/what-we-do/emergency-animal-disease/ead-response-agreement

5 Guidelines for classifying declared areas and premises

When an emergency animal disease (EAD) incident is first suspected, the premises involved would undergo a clinical and/or epidemiological investigation. If the case definition, as defined in the relevant AUSVETPLAN response strategy, is met (ie the index case¹¹), the relevant chief veterinary officer (CVO) or their delegate will determine the premises classification and may declare the premises an infected premises (IP).

After the identification of the first IP, a restricted area (RA) and a control area (CA) may be declared.¹² A transmission area (TA) may also be defined, if appropriate. All premises within these areas will be classified. At the beginning of an EAD incident, the initial premises classifications would be IP, at-risk premises (ARP), premises of relevance (POR), unknown status premises (UP) and zero susceptible species premises (ZP).

Any premises within the RA or CA will have only one classification at any one time. After an epidemiological investigation, clinical assessment, risk assessment or completion of control measures, a premises may be reclassified.

Once the first IP has been identified, intelligence gathering through veterinary epidemiological investigations would quickly lead to the identification of suspect premises (SPs) and trace premises (TPs). These would be high priorities for follow-up investigation by the relevant state or territory authorities. In a worst-case scenario, an SP could become an IP; therefore, SPs need to be investigated as a matter of very high priority. Similarly, investigation and risk assessment of a TP might identify it as an IP, dangerous contact premises (DCP) or dangerous contact processing facility (DCPF). An SP and a TP might also be assessed as negative and qualified as SP-AN or TP-AN, and eventually reclassified as an ARP, POR or ZP.

All premises classifications are subject to change as a result of a modification in the case definition(s) or investigation(s) as the incident response proceeds.

Classifications should be applied with information needs of managers in mind. They should assist managers to monitor and report progress. Premises classifications to be used should be agreed early in a response, so that control centre personnel can apply the correct and consistent classifications and definitions from the outset of the investigation and response.

5.1 Declared areas

Maintaining movement restrictions on areas for long periods has important implications for resource management, animal welfare, business continuity, and socioeconomic impacts on producers and regional communities.

During the course of an EAD response, it may become necessary for a CA or RA to be expanded, as additional geographical areas or new foci of infection are identified. Later in the response, as control is achieved, mechanisms for gradually reducing the size of the CA and RA can be introduced.

¹¹ The first case to come to the attention of investigators

¹² This is invariably the case with highly contagious diseases (eg foot-and-mouth disease, equine/avian/swine influenza, classical swine fever) but may not apply to less contagious diseases (eg Hendra virus, anthrax, Australian bat lyssavirus).

An EAD may involve multiple foci of infection, with several jurisdictions potentially involved. Since disease might be controlled at different rates in different areas, there may be the opportunity to progressively lift restrictions on an area basis. This would involve reclassifying previously declared areas (RAs and CAs), with a staged approach to lifting of movement restrictions. This is a key step in the recovery process and will have positive benefits on the community.

5.1.1 Restricted area (RA)

If an RA is deemed necessary it may be as large as is necessary for satisfactory control, based on epidemiological evidence, geographical features and other factors. The movement of all breeding cattle within the RA will be subject to restrictions.

5.1.2 Control area (CA)

Declaration of a CA that includes contiguous properties is unlikely to assist disease control but could be used to provide additional reassurance during the period of initial investigation.

5.2 Declared premises

Please also refer to the **AUSVETPLAN guidance document *Declared areas and premises classifications*** for more detail on premises status classifications.

5.2.1 Premises status classifications

Infected premises (IP)

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 is present, or there is a reasonable suspicion that either is present, and that the relevant chief veterinary officer or their delegate has declared to be an infected premises.

Suspect premises (SP)

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).

Trace premises (TP)

Temporary classification of a premises that contains a 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).

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.

Approved processing facility (APF)

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.

Approved disposal site (ADS)

A premises that has zero susceptible livestock and that has been approved as a disposal site for animal carcasses or potentially contaminated animal products, wastes or things.

At-risk premises (ARP)

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.

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, dangerous contact premises, dangerous contact processing facility, suspect premises or trace premises.

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.

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.

Zero susceptible species premises (ZP)

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

5.3 Resolving premises and reclassifying declared areas

Maintaining movement restrictions on areas for long periods has important implications for resource management, animal welfare, business continuity, and socioeconomic impacts on producers and regional communities.

During the course of an EAD response, it may become necessary for a CA or RA to be expanded, as additional geographical areas or new foci of infection are identified. Later in the response, as control is achieved, mechanisms for gradually reducing the size of the CA and RA can be introduced.

An EAD may involve multiple foci of infection, with several jurisdictions potentially involved. Since disease might be controlled at different rates in different areas, there may be the opportunity to progressively lift restrictions on an area basis. This would involve reclassifying previously declared

areas (RAs and CAs), with a staged approach to lifting of movement restrictions. This is a key step in the recovery process and will have positive benefits on the community.

6 Movement controls

6.1 Principles

The principles for the recommended quarantine practices and movement controls are as follows:

- Containment and eradication of bovine brucellosis is the highest priority. Therefore, 'normal business movements' are not allowed.
- Live animals pose the greatest risk of disease spread; therefore, their movements from all premises within the restricted area (RA) and control area (CA) must be strictly controlled.
- The outside area (OA) should remain as 'clean' as possible. Therefore, movement of animals from the RA to the OA is prohibited, and movement of products is generally prohibited. Movement of animals and products from the CA to the OA will also be restricted.
- Trace premises (TP) and suspect premises (SP) are temporary classifications, and every effort should be made to resolve the status of these premises as soon as possible.
- The numbers of susceptible animals within the RA should be minimised. Therefore, movements of animals into the RA will be limited and usually for slaughter only.
- Movement restrictions are more stringent within the RA than within the CA, and will be more stringent in the early stages of the response.
- Movement controls may be varied during a response from those listed here. However, this will involve a variation to the agreed Emergency Animal Disease Response Plan, with endorsement by the Consultative Committee on Emergency Animal Diseases (CCEAD) and the National Management Group (NMG).
- Recommended movement controls apply to any movement off a premises, whether on foot or by vehicle, that involves either public or private land.

6.2 Guidelines for issuing permits

In an emergency animal disease (EAD) event, quarantine and movement controls must strike a balance between quick and effective disease control and business continuity. Therefore, it is not appropriate to simply prohibit all movement of animals and products. On the other hand, diligence needs to be applied to minimise the risk of further spread of the disease.

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

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

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

- sources of risk

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

6.3 Types of permits

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

General permit

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

Special permit

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

Emergency permit

An emergency permit is an SpP that specifies strict legal requirements for an otherwise high-risk movement of an animal, to enable emergency veterinary treatment to be delivered, to enable animals to be moved for animal welfare reasons, or to enable any other emergency movement under exceptional circumstances. These permits are issued on a case-by-case basis under the authorisation of the relevant CVO.

Other movement requests

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

6.4 Recommended movement controls

Note: Susceptible stock/animals are defined here as all entire males and females, and exclude females spayed more than 12 months previously and castrated males.

Premises

Quarantine/movement controls	Infected premises, dangerous contact premises and suspect premises
<i>Movement out of:</i>	
Susceptible cattle	Approved under permit direct to immediate slaughter at an approved abattoir, except confirmed infected cows that are close to calving or that have a vaginal discharge. These animals must be destroyed on the property or consigned to a rendering works under supervision
Nonsusceptible cattle	No restriction
Animal products and byproducts	Movement of destroyed cattle is permitted for burial or rendering. No restriction on other products
Hay, crops, grains, wool, eggs, milk and meat	Permitted
<i>Movement in and out of:</i>	
People	No restriction
Horses	No restriction unless showing clinical signs of the disease. Horses confirmed with <i>B. abortus</i> must be strictly isolated from all cattle
Vehicles and equipment	Livestock transport vehicles to be thoroughly cleaned if involved with known infected animals
<i>Movement in of:</i>	
Susceptible cattle	Restrictions apply. Introductions should not be allowed until <i>B. abortus</i> is thought to have been eliminated
Nonsusceptible cattle	No restriction

Restricted area

Quarantine/ movement control	Restricted area (if declared)
<i>Movement in of:</i>	
Susceptible stock	Controlled by inspector using permits
<i>Movement out of:</i>	
Susceptible stock	Until disease status established, susceptible animals are permitted to move for slaughter only; then moved under permit
<i>Movement within of:</i>	
Susceptible stock	Controlled by inspector using permits
<i>Movement through of:</i>	
Susceptible stock	Controlled by inspector using permits
<i>Movement of specified products</i>	No restriction
<i>Movement of people and equipment</i>	No restriction
<i>Movement of vehicles</i>	No requirements, except livestock transport vehicles to be cleaned if involved with known infected or suspect animals
<i>Risk enterprises</i>	Not applicable
<i>Sales, shows (gatherings of susceptible animals)</i>	Covered by above restrictions
<i>Stock routes, rights of way</i>	Covered by above restrictions
<i>Containment of susceptible animals</i>	Not applicable

7 Surveillance and proof of freedom

7.1 Surveillance

7.1.1 Specific considerations

The objective of surveillance is to meet World Organisation for Animal Health (OIE) requirements, as outlined in Chapter 8.4 and Article 8.4.4 of the OIE *Terrestrial animal health code*.

7.2 Proof of freedom

The OIE *Terrestrial animal health code* has two key criteria related to proof of freedom. The first requires confirmation that the rate of brucellosis infection is less than 0.2% of the cattle herds in the country or area under consideration. This indicates that the presence of a small number of infected herds should not affect brucellosis-free status. It also highlights the importance of prompt action to restrict the number of herds that become infected. The second key criterion requires that no vaccine should have been used for at least the past 3 years.

Nevertheless, a formal declaration of continuing freedom may assist the resumption of trade in live breeding stock to countries that are brucellosis-free and reassure other countries that the disease has been effectively managed.

Proof of freedom from brucellosis can best be achieved by the reporting and investigation of abortions, milk ring testing at dairy factories and use of targeted serological testing.

After an outbreak of brucellosis, a survey of the cattle population would be required to demonstrate proof of freedom. This may be carried out by a combination of field and abattoir serological testing, and by milk ring tests of dairy herds. The survey would concentrate on all herds affected, those in contact and neighbours, and be based on the results of tracing of cattle movements.

Initial serological surveillance should target former infected premises (IPs), dangerous contact premises (DCPs) and suspect premises (SPs), which require two negative tests at 6-month intervals, because they were either:

- depopulated, in which case testing of the new herd after repopulation is required; or
- subject to test and slaughter, and testing of all breeding cattle until a negative herd test has been achieved.

On DCPs and SPs where no evidence of infection was found on initial investigation, milk ring testing or serological evidence of continued freedom would be sufficient. Serological evidence would involve the testing of breeding cattle over the age of 6 months to achieve 99% confidence of less than 1% seropositivity.

In herds with no history of infection and where it has been established that there has been no contact with known affected properties, the only action required is to ensure that the owners are aware of the disease and the need to promptly report abortions so that they can be fully investigated.

Where vaccinates are present in a herd, 3 years must elapse from the time of the last vaccination to establish freedom.

Appendix 1

BOVINE BRUCELLOSIS FACT SHEET

Disease and cause

Brucellosis in cattle is primarily caused by the bacterium *Brucella abortus*.

Occurrence in Australia

Bovine brucellosis caused by *B. abortus* is not present in Australia.

Species affected

Infection with *B. abortus* has been recorded in most species of domestic livestock, as well as in dogs, cats and humans.

Key signs in cattle

The primary clinical sign in female cattle is a significant number of late-term (5–7 months) abortions. In a population that has not been exposed to the disease before, these may appear as an ‘abortion storm’, with many cows aborting over a short period.

In bulls, signs include inflammation of the testis (orchitis) and lameness due to bursitis.

Spread

B. abortus is usually transmitted by ingestion of contaminated feed or water, or by licking an infected placenta, calf or fetus, or the genitalia of an infected cow soon after it has aborted or calved.

Persistence of the agent

Under ideal conditions, *B. abortus* can persist in organic materials such as faeces, abortion fluids and milk for up to 6 months. It may survive up to 8 months in an aborted fetus.

Appendix 2

SPECIMENS YIELDING *BRUCELLA ABORTUS* FROM KNOWN INFECTED COWS AND HEIFERS

Cows

Specimen	No. examined	No. positive on culture	%
Lymph nodes			
Parotid	136	70	51.5
Mandibular (submaxillary)	136	70	51.5
Medial retropharyngeal	137	94	68.6
Caudal superficial cervical (prescapular)	137	78	56.9
Caudal mediastinal	136	47	34.6
Hepatic	90	16	17.8
Jejunal mesenteric	88	6	6.8
Medial iliac	137	101	73.7
Subiliac (prefemoral)	136	93	68.4
Mammary (superficial inguinal)	136	121	88.0
Spleen	136	32	23.5
Udder	91	75	82.4
Uterine caruncle or fetal tissue	136	57	41.9
Milk	107	90	84.1

Source: Corner et al 1987

Heifers

Specimen	No. examined	No. positive on culture	%
Lymph nodes			
Parotid	61	42	68.9
Mandibular (submaxillary)	61	45	73.8
Medial retropharyngeal	61	38	62.3
Caudal superficial cervical (prescapular)	61	36	59.0
Caudal mediastinal	61	31	50.8
Jejunal mesenteric	24	8	33.3
Medial iliac	61	36	59.0
Subiliac (prefemoral)	61	39	63.9

Specimen	No. examined	No. positive on culture	%
Mammary (superficial inguinal)	61	36	59.0
Spleen	61	30	49.2
Liver	23	4	17.4
Lung	22	5	22.7
Kidney	22	6	27.3
Uterine caruncle or fetal tissue	58	12	20.7
Udder	22	4	18.2
Milk	5	5	100.0

Note: A heifer is defined here as an animal <18 months of age (ie having no permanent incision teeth).

Source: Corner et al (1987)

Appendix 3

WORK HEALTH AND SAFETY ISSUES FOR PEOPLE HANDLING *BRUCELLA* REACTORS COMMITTED FOR DESTRUCTION

This appendix addresses work health and safety issues for transporters, abattoir workers and other people involved in livestock and carcase handling where *Brucella* reactors have been identified for destruction. All people in contact with reactors must be aware of the personal procedures outlined in this appendix.

Infection occurs mainly through handling infected fetuses, birth membranes or mammary glands, or ingesting raw milk. Meat and meat products pose very slight risk. Cows that have aborted from brucellosis are thought to pose a negligible risk 3 weeks later.

Personal procedures for handling a *Brucella* reactor

All personnel handling potentially infected animals should be thoroughly informed of the danger of contracting the disease from carcasses, milk, blood, urine, faeces, and birth products or discharges. Personnel should be made aware that human infection can occur readily through:

- damaged or intact skin
- the conjunctiva
- the respiratory tree
- (more rarely) the oral route.

All personnel physically handling the carcase should wear the following protective apparel:

- long rubber gloves
- protective eye shields
- masks that form a seal on the face, covering the mouth and nose
- impervious apron
- impervious boots.

Personal hygiene while working with carcasses is extremely important. Protective apparel such as gloves and eyeshields should be washed and disinfected immediately after use. Masks should be disposed of safely.

Individuals with uncovered wounds should not be permitted to perform these procedures. Cuts and abrasions that occur in the process of carcase handling should be treated immediately. Eating and smoking are not allowed during handling or slaughtering procedures. Splashes of animal material on clothing, equipment or skin should be removed as soon as possible.

For abattoir workers, particular care should be taken when handling udders, uteri, bladders, brisket saws and knives in slaughtering positions where there is a risk of spillage.

Occupationally exposed groups should have access to specialised medical services to facilitate the early and correct diagnosis of brucellosis.

Physical procedures for handling a *Brucella* reactor

Where a decision has been made to destroy a reactor, a decision will also be made on where the destruction will be carried out. Destruction will occur at an abattoir within the control area, where practicable. Destruction may be ordered to take place on the infected premises when a heavily pregnant animal is identified or where the risk of spreading infection during transport to an abattoir

is deemed to be too great. Taking into account the personal procedures listed above, transport workers must ensure that vehicles used to transport reactors are disinfected following each journey.

Destruction of reactor(s) at abattoir

Animals that have reacted to diagnostic tests for brucellosis should be segregated, before slaughter, in an area that can readily be disinfected. Such animals should be slaughtered without unreasonable delay after arrival at an abattoir; if possible, they should be slaughtered at the end of the day's operations.

All slaughtering, washing and cleaning procedures must be carried out in a fashion that minimises the opportunity for spillage or splash of potentially infective fluids.

The blood from such animals should not be saved for human consumption.

For cattle, udders must be carefully dissected away from the underlying suspensory tissues to prevent spillage of milk. Such a precaution is most important if the cow has been lactating and the udder is unduly distended.

'Ringing' of the anus and vulva followed by removal of the external anal and vulval skin and then sealing of the rectum and vagina must be performed by a competent person.

Removal of the urinary bladder should be performed only after the neck of the bladder is securely tied.

Removal of the uterus should be performed by a competent person. If a cow is pregnant, no disruption to the uterus should occur and no attempt to save the slink (fetus) is allowed.

Opening of the nuchal bursa should be supervised by a person with meat inspection experience. Any evidence of the presence of 'rice grain'-like objects in the bursal fluid should warrant condemnation of the neck and thoracic tissues back to the third thoracic vertebra.

Strict attention should be paid to the limb joints, particularly the stifle, for possible presence of a hygroma. The presence of any such fluid-filled swelling (determined by palpation only) warrants the removal of that limb at the next joint above (ie closer to the carcass).

Inspectors on the head chain should supervise the removal of both tonsils. The pharyngeal lymph nodes should be left until last for slicing, and then the entire tongue root should be removed and disposed of in a sanitary manner as condemned tissue. The inspector should then sterilise their knife.

Inspectors on the 'fronts' should leave the slicing of the superficial inguinal lymph nodes until last. The inspector should then sterilise their knife.

As frequently as possible, all utensils, instruments, machinery, chutes, floors and other areas of potential contamination should be cleaned using standard procedures and agents, and then cleansed with water at temperatures above 82 °C.

Facilities for washing and disinfection should be made available.

Destruction of reactor(s) on infected premises

Animals that have reacted to diagnostic tests for brucellosis should be segregated, before slaughter, in an area that can readily be disinfected.

Unless slashing is necessary as part of the burial process, the carcass should remain intact.

The reactor should be buried or burned, whichever is the most practicable in the situation (refer to the **AUSVETPLAN operational manual *Disposal***).

All utensils, instruments and machinery should be cleaned using procedures and agents outlined in the **AUSVETPLAN operational manual *Decontamination*** to minimise the risk of human infection.

Glossary

Standard AUSVETPLAN terms

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, hoofs, bones, fertiliser).
Animal Health Committee	A committee whose members are the chief veterinary officers of the Commonwealth, states and territories, along with representatives from the CSIRO Australian Centre for Disease Preparedness (CSIRO-ACDP) and the Australian Government Department of Agriculture, Water and the Environment. There are also observers from Animal Health Australia, Wildlife Health Australia, and the New Zealand Ministry for Primary Industries. The committee provides advice to the National Biosecurity Committee on animal health matters, focusing on technical issues and regulatory policy. <i>See also</i> National Biosecurity Committee
Animal products	Meat, meat products and other products of animal origin (eg eggs, milk) for human consumption or for use in animal feedstuff.
Approved disposal site	A premises that has zero susceptible livestock and has been approved as a disposal site for animal carcasses, or potentially contaminated animal products, wastes or things.
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, Water and the Environment who manages international animal health commitments and the Australian Government's response to an animal disease outbreak. <i>See also</i> Chief veterinary officer
AUSVETPLAN	<i>Australian Veterinary Emergency Plan</i> . Nationally agreed resources that guide decision making in the response to emergency animal diseases (EADs). It outlines Australia's preferred approach to responding to EADs of national significance, and supports efficient, effective and coherent responses to these diseases.
Carcase	The body of an animal slaughtered for food.
Carcass	The body of an animal that died in the field.
Chief veterinary officer (CVO)	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. <i>See also</i> Australian Chief Veterinary Officer

Compartmentalisation	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, to facilitate disease control and/or trade.
Compensation	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. <i>See also</i> Cost-sharing arrangements, Emergency Animal Disease Response Agreement
Consultative Committee on Emergency Animal Diseases (CCEAD)	The key technical coordinating body for animal health emergencies. Members are state and territory chief veterinary officers, representatives of CSIRO-ACDP and the relevant industries, and the Australian Chief Veterinary Officer as chair.
Control area (CA)	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).
Cost-sharing arrangements	Arrangements agreed between governments (national and state/territory) and livestock industries for sharing the costs of emergency animal disease responses. <i>See also</i> Compensation, Emergency Animal Disease Response Agreement
Dangerous contact animal	A susceptible animal that has been designated as being exposed to other infected animals or potentially infectious products following tracing and epidemiological investigation.
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.

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	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. <i>See also</i> Endemic animal disease, Exotic animal disease
Emergency Animal Disease Response Agreement	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. <i>See also</i> Compensation, Cost-sharing arrangements
Endemic animal disease	A disease affecting animals (which may include humans) that is known to occur in Australia. <i>See also</i> Emergency animal disease, Exotic animal disease
Enterprise	<i>See</i> Risk enterprise
Enzyme-linked immunosorbent assay (ELISA)	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.
Epidemiological investigation	An investigation to identify and qualify the risk factors associated with the disease. <i>See also</i> Veterinary investigation
Epidemiology	The study of disease in populations and of factors that determine its occurrence.
Exotic animal disease	A disease affecting animals (which may include humans) that does not normally occur in Australia. <i>See also</i> Emergency animal disease, Endemic animal disease
Exotic fauna/feral animals	<i>See</i> Wild animals
Fomites	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.
General permit	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. <i>See also</i> Special permit
In-contact animals	Animals that have had close contact with infected animals, such as noninfected animals in the same group as infected animals.
Incubation period	The period that elapses between the introduction of a pathogen into an animal and the first clinical signs of the disease.
Index case	The first case of the disease to be diagnosed in a disease outbreak. <i>See also</i> Index property
Index property	The property on which the index case is found. <i>See also</i> Index case
Infected premises (IP)	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 is present, or there is a reasonable suspicion that either is present, and that the relevant chief veterinary officer or their delegate has declared to be an infected premises.
Local control centre	An emergency operations centre responsible for the command and control of field operations in a defined area.
Monitoring	Routine collection of data for assessing the health status of a population or the level of contamination of a site for remediation purposes. <i>See also</i> Surveillance
Movement control	Restrictions placed on the movement of animals, people and other things to prevent the spread of disease.
National Biosecurity Committee	A committee that was formally established under the Intergovernmental Agreement on Biosecurity (IGAB). The IGAB was signed on 13 January 2012, and signatories include all states and territories except Tasmania. The committee provides advice to the Agriculture Senior Officials Committee and the Agriculture Ministers' Forum on national biosecurity issues, and on the IGAB.
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, Water and the Environment 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/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/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.
Proof of freedom	Reaching a point following an outbreak and post-outbreak surveillance when freedom from the disease can be claimed with a reasonable level of statistical confidence.
Quarantine	Legally enforceable requirement that prevents or minimises spread of pests and disease agents by controlling the movement of 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 and 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 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	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. <i>See also</i> General permit
Specificity	The proportion of truly negative units that are correctly identified as negative by a test. <i>See also</i> Sensitivity
Stamping out	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.
State coordination centre	The emergency operations centre that directs the disease control operations to be undertaken in a state or territory.
Surveillance	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.
Susceptible animals	Animals that can be infected with a particular disease.
Suspect animal	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. or

	An animal not known to have been exposed to a disease agent but showing clinical signs requiring differential diagnosis.
Suspect premises (SP)	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).
Swill	<p>Also known as 'prohibited pig feed', means material of mammalian origin, or any substance that has come in contact with this material, but does not include:</p> <p>(i) Milk, milk products or milk by-products either of Australian provenance or legally imported for stockfeed use into Australia.</p> <p>(ii) Material containing flesh, bones, blood, offal or mammal carcasses which is treated by an approved process.¹</p> <p>(iii) A carcass or part of a domestic pig, born and raised on the property on which the pig or pigs that are administered the part are held, that is administered for therapeutic purposes in accordance with the written instructions of a veterinary practitioner.</p> <p>(iv) Material used under an individual and defined-period permit issued by a jurisdiction for the purposes of research or baiting.</p> <p>¹ In terms of (ii), approved processes are:</p> <ol style="list-style-type: none"> 1. rendering in accordance with the 'Australian Standard for the Hygienic Rendering of Animal Products' 2. under jurisdictional permit, cooking processes subject to compliance verification that ensure that a core temperature of at least 100 °C for a minimum of 30 minutes, or equivalent, has been reached. 3. treatment of cooking oil, which has been used for cooking in Australia, in accordance with the 'National Standard for Recycling of Used Cooking Fats and Oils intended for Animal Feeds' 4. under jurisdictional permit, any other nationally agreed process approved by AHC for which an acceptable risk assessment has been undertaken and that is subject to compliance verification. <p>The national definition is a minimum standard. Some jurisdictions have additional conditions for swill feeding that pig producers in those jurisdictions must comply with, over and above the requirements of the national definition.</p>
Swill feeding	<p>Also known as 'feeding prohibited pig feed', it includes:</p> <ul style="list-style-type: none"> • feeding, or allowing or directing another person to feed, prohibited pig feed to a pig • allowing a pig to have access to prohibited pig feed • the collection and storage or possession of prohibited pig feed on a premises where one or more pigs are kept

	<ul style="list-style-type: none"> supplying to another person prohibited pig feed that the supplier knows is for feeding to any pig. <p>This definition was endorsed by the Agriculture Ministers' Council through AGMIN OOS 04/2014.</p>
Trace premises (TP)	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).
Tracing	The process of locating animals, people or other items that may be implicated in the spread of disease, so that appropriate action can be taken.
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.
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.
- adjuvanted	A vaccine in which one or several disease-causing agents are combined with an adjuvant (a substance that increases the immune response).
- attenuated	A vaccine prepared from infective or 'live' microbes that are less pathogenic but retain their ability to induce protective immunity.
- gene deleted	An attenuated or inactivated vaccine in which genes for non-essential surface glycoproteins have been removed by genetic engineering. This provides a useful immunological marker for the vaccine virus compared with the wild virus.
- inactivated	A vaccine prepared from a virus that has been inactivated ('killed') by chemical or physical treatment.
- recombinant	A vaccine produced from virus that has been genetically engineered to contain only selected genes, including those causing the immunogenic effect.
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).
Wool	Sheep wool.
Zero susceptible species premises (ZP)	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, to facilitate disease control and/or trade.
Zoonosis	A disease of animals that can be transmitted to humans.

Abbreviations

Disease-specific abbreviations

Abbreviation	Full title
CFT	complement fixation test
MRT	milk ring test
RBPT	Rose Bengal plate test

Standard AUSVETPLAN abbreviations

Abbreviation	Full title
ACDP	Australian Centre for Disease Preparedness
AN	assessed negative
ARP	at-risk premises
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
DCPF	dangerous contact processing facility
EAD	emergency animal disease
EADRA	Emergency Animal Disease Response Agreement
EADRP	Emergency Animal Disease Response Plan
EDTA	ethylenediaminetetraacetic acid (anticoagulant for whole blood)
ELISA	enzyme-linked immunosorbent assay
GP	general permit
IETS	International Embryo Technology Society
IP	infected premises
LCC	local control centre
NMG	National Management Group
OA	outside area

Abbreviation	Full title
OIE	World Organisation for Animal Health
PCR	polymerase chain reaction
POR	premises of relevance
RA	restricted area
RP	resolved premises
SCC	state coordination centre
SP	suspect premises
SpP	special permit
TP	trace premises
UP	unknown status premises
ZP	zero susceptible stock premises

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