NHMRC SPECIAL EXPERT COMMITTEE ON TRANSMISSIBLE SPONGIFORM ENCEPHALOPATHIES	Face-to face meeting 5.
Agenda Item 6.1: Risk Assessment in relation to importation of cattle *“The likelihood that bovine spongiform encephalopathy (BSE) established in the Australian herd as a result of the importation of cattle from the UK and Europe (1980 to 1991)”*,	Date: 7 November, 2001 Location: Canberra

RISK ASSESSMENT

The likelihood that bovine spongiform encephalopathy (BSE) established in the Australian herd as a result of the importation of cattle from the UK and Europe (1980 to 1991)

Executive summary

This paper discusses preliminary results of an investigation of the likelihood that BSE became established within the Australian cattle herd as a result of the importation of cattle from the United Kingdom (UK) and continental Europe between 1980 and 1991.

Following the confirmation of BSE in an indigenous cow in Japan, an investigation revealed that 24 cattle had also been imported from Japan via the United States in January 1998. These animals were traced to one property in NSW. Two of the 24 animals had died from misadventure, and the remaining 22 were placed under quarantine surveillance in accordance with Section 55A, Regulation 36 of the Quarantine Act. This section of the ‘Act prohibits the unauthorised movement of the 22 cattle, or their sale for slaughter, and ensures that their carcasses will be disposed of in a manner that meets with the approval of the Australian Quarantine and Inspection Service.

The investigation of UK and European cattle was carried out in two phases.

1. <u>The release assessment</u>: a *quantitative* assessment of the likelihood that at least one infected animal entered Australia, and was subsequently slaughtered, prior to the instigation of a ban on the inclusion of ruminant materials in ruminant feed. This assessment was based on the published scientific literature on the epidemiology of BSE in the UK and Europe and on quarantine station records, surveillance records and stud records describing the origin, importation details, management and (where relevant) disposal of imported animals. It was enhanced by a valuable investigation in the UK where original documentation was viewed, including documentation from breed societies.

2. <u>The exposure assessment</u>: a *qualitative* assessment of the likelihood that the BSE infective agent would have established within the Australian cattle herd, if at least one BSE-infected animal had been imported and sent to slaughter before the ban. This assessment was based on an examination of the ‘pathway’ of steps, or events, necessary for infection to have been disseminated undetected from the carcass of an infected imported animal to the Australian cattle herd.

From the release assessment, it was concluded that the likelihood that one or more infected animals were imported and sent to slaughter before the ban is approximately 1%. This was qualitatively interpreted as a 'very low' likelihood. However, quantitative assessment does not account for the history of individual animals (see Annex 2). A more complete picture is obtained when the investigations in the UK are considered as well. When this happens, the "very low" likelihood decreases and the figure of 1% can be considered a conservative upper limit.

Although not its primary focus, the release assessment also showed that the probability that the European Commission's 'tolerance' for BSE-infected animals in a country with a Geographic BSE Risk (GBR) rating of Level 1 (i.e. 1 animal per 10 million head) would have been exceeded by the importation of infected animals alone, was virtually zero. This figure is lower than that supplied by Australia (AFFA, 2000a) to the Scientific Steering Committee (approximately 0.43%), as the assessment was based on refined estimates of the incidence of BSE within various sub-populations in the UK and Europe from which the imported cattle were sourced.

From the exposure assessment it was concluded that the likelihood that BSE would have established undetected in the Australian cattle herd, had at least one infected animal been sent to slaughter before the ban, was 'negligible'. This result was derived from the combination likelihoods ascribed to each of the following necessary steps, or events;

- that carcass components from a slaughtered infected (incubating or clinically affected) animal were rendered to meat and bone meal (MBM) - *likely*
- that MBM thus derived was infectious for Australian cattle - *very unlikely*
- that infectious MBM was fed to Australian cattle - *very unlikely*
- that Australian cattle fed infectious MBM remain alive and incubating the disease, *or* alive and clinically affected but undetected by Australia's passive and active surveillance for BSE - *very unlikely*

When the results of the two assessments were combined, the overall likelihood that BSE became established within the Australian cattle herd as a result of the importation of cattle from the UK and Europe was considered 'negligible'.

The importance of this result is the support it lends to Australia's case for classification as a Category 1 country under new European Commission and New Zealand legislation. BSE has never been observed in Australia and, despite the importation of cattle from the UK, Europe and Japan (via the United States), it is clear that Australia remains free from this important trade-limiting animal disease.

Introduction

In the years 1980 to 1988, 204 cattle were imported from the United Kingdom. Importations were halted in 1988 with the emergence of BSE in the UK. Between 1987 and 1991, 289 cattle were imported from Europe.[1] Importation from Europe ceased in 1991 when it became clear that BSE was not restricted to the British Isles. The objective of this study was to investigate the likelihood that BSE became established undetected within the Australian cattle herd as a result of the importation of the 493 (i.e. 204 plus 289) cattle from UK and Europe.[2]

The premise underlying the investigation was that in order to become established within the Australian cattle herd, the BSE infective agent was recycled through the feeding of meat and bone meal (MBM) derived from infected imported animals. Subsequent recycling of infected Australian cattle through the same system might then have led to amplification of the disease and its possible establishment in the cattle population. There is some observational epidemiological evidence to suggest that BSE may also be transferred vertically from dam to calf (SEAC, 1997), although this route has only been documented in the situation where the dam is *clinically* affected (Taylor et al, 1995) — as there is no evidence of clinical disease amongst imported cattle (live or dead), this was not considered further. No evidence exists to suggest that the BSE infective agent may be transferred through the semen or embryos (Wrathall et al, 1990) of infected cattle or *in utero* (Middleton and Barlow, 1993; European Commission, 1999).

It was also reasoned that imported animals that could not have been infected with BSE or could not have been incorporated in the MBM that was fed to Australian cattle, were not relevant to the investigation — these included;

- animals sourced from farms in the UK that continue to remain free of cases of BSE
- animals born before 1 July 1976
- animals still alive or re-exported
- animals known to have died and been disposed of outside the commercial slaughter / MBM system
- animals known to have been slaughtered commercially after the instigation, in October 1997, of the ban on inclusion of ruminant-derived material in ruminant feed
- animals that are known to have been more than 10 years of age at the time of death

The exclusion criteria are discussed individually below. The numbers of animals removed from the analysis at each step is documented in Table 1 and Table 2. In cases where information was inadequate to confirm that an animal had satisfied one or other criterion, a conservative stance was taken and the animal retained in the analysis.

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[1] In this assessment, Europe is taken to mean ‘continental Europe’. The term thus excludes the UK, and includes countries such as Switzerland that are not members of the EU.

[2] Following the confirmation of BSE in an indigenous cow in Japan, an investigation revealed that 24 cattle had also been imported from Japan via the United States in January 1988. These animals were traced to one property in NSW. Two of the 24 animals had died from misadventure, and the remaining 22 were placed under quarantine surveillance in accordance with Section 55A, Regulation 36 of the Quarantine Act. This section of the ‘Act prohibits the unauthorised movement of the 22 cattle, or their sale for slaughter, and ensures that their carcasses will be disposed of in a manner that meets with the approval of the Australian Quarantine and Inspection Service.

Significantly, this systematic exclusion process left only *five* UK animals in the analysis.

Animals sourced from farms in the UK that continue to remain free of cases of BSE. All but 11 cattle imported from the UK were traced to their farm of origin. This was achieved through research in Australia and the UK, including the assistance of breed societies in both countries. The UK Department of Environment, Food and Rural Affairs (DEFRA) then checked the BSE history of these farms against the UK BSE databases and, where confirmed, the index case noted. Farms that had not reported at least one case of BSE to date were removed from the quantitative assessment.

Animals born before 1 July 1976. BSE was officially recognised as a new disease in 1986. Subsequent investigations confirmed that clinical cases had been observed since December 1984, with suspect cases as early as October 1983. Anecdotal reports suggest that sporadic cases of BSE may have occurred several years before this.

By correlating this with information regarding the age of affected animals, and the results of simulation studies (Wilesmith et al, 1988) suggesting that infection occurred in the first 6 months of life, it was found that the UK BSE epidemic was probably initiated in 1974. Since the cumulative incidence of BSE in animals born before 1 July 1976 was immeasurably small, this date was set as the cut-off for the quantitative assessment.

Animals still alive or re-exported. Since the youngest of the imported animals was born in May, 1987, those remaining alive must be at least 14 years of age. This age substantially exceeds the expected incubation period (3-8 years) for BSE (Wilesmith, 1988; Anderson, 1996). Animals that have been re-exported are no longer relevant to Australia's BSE status, although the group nevertheless remains free from clinical disease.

Animals known to have died and been disposed of outside the commercial slaughter / MBM system. The premise underlying this investigation was that in order to become established within the Australian cattle herd, the BSE infective agent was recycled through the feeding of meat and bone meal (MBM) derived from infected imported animals. Subsequent recycling of infected Australian cattle through the same system might then have led to amplification of the disease and its possible establishment in the cattle population. Given this, it is clear that animals that are know to have died and to have been disposed of outside the commercial slaughter/MBM system were not relevant to the investigation.

Animals known to have been slaughtered commercially after the instigation, in October 1997, of the ban on inclusion of ruminant-derived material in ruminant feed. This criterion is an extension of the above — that is, cattle slaughtered after the instigation of the feed ban could not have been recycled in MBM to other cattle and could not, therefore have led to amplification of the disease within the Australian cattle herd.

Animals that are known to have been more than 10 years of age at the time of death. The incubation period for BSE is thought to range between 3 and 8 years (Wilesmith et al 1988, Anderson et al 1996). Since infection of UK and European cattle is believed to have occurred through the feeding of MBM to calves less than 6 months old (Wilesmith 1998), imported cattle more than 10 years of age that satisfied ante-mortem abattoir inspection were not considered a potential source of the BSE infectious agent.

Table 1 Cattle imported from the UK

Type of cattle imported	BSE recorded on farm of origin?	Reason for removal from analysis						Number remaining in the analysis
		Number imported	Born before July 1976	Currently alive or re-export.	Died but not rendered	Killed after the ban	Killed ≥ 10yo	
Dairy	Yes	18	2	0	2	2	10	2
	No	44	N/A[†]	N/A	N/A	N/A	N/A	N/A
Beef	Yes	15	0	2	10	0	1	2
	No	118	N/A	N/A	N/A	N/A	N/A	N/A
Mixed	Yes	2	0	1	0	0	0	1
	No	7	N/A	N/A	N/A	N/A	N/A	N/A
Total		**204**			**➔**			**5**

[†] Not applicable — animals sourced from farms that had not reported a case of BSE were removed from the assessment.

Table 2 Cattle imported from Europe

Source	Number imported	Born before July 1976	Currently alive or re-export.	Died but not rendered	Killed after the ban	Killed ≥ 10yo	Number remaining in the analysis
Austria	8	0	0	2	1	-	5
Denmark	53	0	14	14	6	-	19
France	122	0	61	27	6	-	28
Germany	86	0	21	17	5	-	43
Italy	9	0	0	0	0	-	9
Norway	2	0	0	0	0	-	2
Switzerland	9	0	2	0	0	-	7
Total	**281**	**0**	**98**	**60**	**18**	**-**	**113**

The investigation was carried out in two phases.

The *first* (termed the 'release assessment') provided a probability distribution for the number of infected cattle that may have been imported, and subsequently sent to slaughter, before the ban on inclusion of ruminant-derived material in ruminant feed.[3] The probability distribution was then used to generate the more specific likelihood that 'at least one infected animal entered the Australian cattle slaughter system'. Although not its primary focus, the release assessment also enabled estimation of the likelihood that the European Commission's 'tolerance' for BSE-infected animals in a country with a GBR 1 rating (i.e. one animal per 10 million head) would have been exceeded by the importation of infected animals alone. A probability statement in this form (approximately 0.43%) was provided in a submission to the European Commission's Scientific Steering Committee (SSC), as a part of Australia's bid for classification as a GBR 1 country (AFFA, 2000a).

The *second* phase of the investigation (termed the 'exposure assessment') provided an estimate of the likelihood that the BSE infective agent would have established undetected within the Australian cattle herd, if at least one BSE-infected animal had been imported and sent to slaughter before the ban. The exposure assessment was based on an examination of the 'pathway' of steps, or events, necessary for infection to have been disseminated from the carcass of an infected imported animal to the Australian cattle herd.

The results obtained from the release and exposure assessments were subsequently combined to provide an overall risk estimate. This two-stage approach enabled factors relevant to each of the assessments to be considered independently, but within the framework of the overall pathway of events necessary if BSE were to have established undetected in Australia.

Release assessment

Data for the release assessment were obtained from three key sources;

- the published scientific literature on the epidemiology of BSE in the UK and Europe — in particular, a paper titled *Risk of BSE from the import of cattle from the United Kingdom into countries of the European Union* (Schreuder et al, 1997).
- a data base compiled for cattle imported from the UK and Europe - these data were compiled from a variety of sources, including quarantine station records, surveillance records on file and stud records supplied by owners and breed societies in Australian and overseas.[4]

Additional efforts were made to backtrace all cattle imported from the UK to their farms of origin and to determine the BSE history of these farms of origin. The results of this investigation are set out in Annex 2. Investigations were made at the:

- Department for Environment Food and Rural Affairs, Page Street, London,
- Veterinary Laboratory Service at Central Veterinary Laboratory, Weybridge,
- States of Jersey Department of Agriculture and Fisheries,
- Isle of Man Department of Agriculture, Fisheries and Forestry, and
- Various cattle breed societies in the UK.

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3 This is abbreviated hereafter as 'entry into the Australian cattle slaughter system'.

4 Some written records were unavailable as, in many cases, the memories of owners or their surviving relatives or former staff were relied upon for information about events that took place between 10 and 21 years ago.

Correlation of risk factors identified in the scientific literature with the characteristics of imported animals enabled the identification of sub-populations for which the incidence of BSE is known to be markedly lower than that generally reported. Importation data (after the removal of animals not relevant to the analysis — see Table 1 and Table 2) was stratified according to the source of imported animals (UK or Europe) and their purpose (dairy, beef or dual-purpose[5]). For the cattle from the UK, each of these subgroups was further stratified according to birth cohort. The result of this process is illustrated in Table 3 below.

Table 3 Stratification of imported animals by source (UK or Europe), utility (dairy, beef or dual-purpose) and birth cohort

Source	**Utility**	**Birth cohort (19_ _)**												**Total**
		76 - 77	**77 - 78**	**78 - 79**	**79 – 80**	**80 - 81**	**81 - 82**	**82 - 83**	**83 – 84**	**84 - 85**	**85 – 86**	**86 - 87**	**87 - 88**	
UK	Dairy	0	0	0	0	0	2	0	0	0	0	0	0	2
	Beef	1	0	0	1	0	0	0	0	0	0	0	0	2
	Dual	0	0	0	0	0	0	0	1	0	0	0	0	1
	Total	1	0	0	1	0	2	0	1	0	0	0	0	**5**
		78 - 79	**79 - 80**	**80 - 81**	**81 – 82**	**82 - 83**	**83 - 84**	**84 - 85**	**85 - 86**	**86 - 87**	**87 – 88**	**88 - 89**	**89 - 90**	
Europe	Dairy	-	-	-	-	-	-	-	0	0	0	0	0	0
	Beef †	-	-	-	-	-	-	-	20	0	16	11	13	60
	Dual	-	-	-	-	-	-	-	23	0	1	27	2	53
	Total	-	-	-	-	-	-	-	43	0	17	38	15	**113**

† Cattle imported from Europe were either of beef or dual purpose breed

Stratification of import data was considered a critical step in the investigation, since the probability calculated from the release assessment was found to be extremely sensitive to the incidence of BSE in the particular sub-population from which each group of animals was sourced. It was noted that use of a single overall estimate for the incidence of BSE in the cattle population in each exporting country would lead to an unrealistic probability distribution for the number of infected animals entering the cattle slaughter system in Australia.

Estimation of the incidence of BSE in each stratum is discussed individually below:

- *Estimating the incidence of BSE in cattle from UK*: An estimate for the incidence of BSE within each identified birth cohort was obtained directly from Schreuder et al (1997). The numbers of cases of BSE in Great Britain from 1975 to 1994 (by their year of birth) were obtained from BSE records. From these data, the annual incidence of BSE in dairy and beef suckler herds combined was calculated for each 12 month cohort from 1976 to 1990, using the total adult cattle population

[5] Dual-purpose breeds included British White, Dexter, Simmentals, Norwegian Red, Braunvieh and Gelbvieh. In Australia, dual-purpose breeds are used almost exclusively for the production of purebred or crossbred beef

in Great Britain. When the overall cumulative incidence (CI) was almost 5.4% in 1987/88, the CI peaks were 7.1 % and 0.8% for dairy herds and beef herds respectively. The CI for dairy and beef herds for all other birth cohorts were adjusted accordingly.

- *Estimating the incidence of BSE in cattle from Europe*: Age cohort data were not available for European cattle (Table 3). Given this, AQIS records showed that the average age of all cattle imported from the UK into Australia from 1980 to 1988 was 1.54 years. In this study, it was assumed that this was also the average age of cattle imported from Europe. Thus, the age cohort of each animal imported from Europe was calculated by deducting the average age from the year of import.

  The annual incidence of BSE in European cattle was also unavailable. However, France, with a population of 20.4 million cattle had reported 302 cases of BSE by 31 March 2001. At the same time, the UK, with a population of 5.5 million cattle had reported 179,683 cases. This suggests that the incidence of BSE in France was (very approximately) 0.0005 of the incidence of BSE in UK. This conservative estimate was subsequently adopted for all European countries and all birth cohorts.

Estimates for the incidence of BSE specific to source (UK or Europe), utility (dairy, beef or dual purpose) and (where available) birth cohort, were incorporated into a modification of the quantitative model cited in an Australian submission to the SSC (Annex 1). The risk of importing a detected, recognised and confirmed BSE case was calculated from the following formula:

Risk of importing an infected animal (R) = Sum (n x CI) in which:

n = number of animals retained for analysis in a certain birth cohort (Table 3)

CI = cumulative incidence in animals born in that birth cohort.

The Poisson probability distribution was applied to the risk R to generate an estimate for the more specific likelihood that at least one infected animal may have entered the cattle slaughter system.

Although not its primary focus, the probability distribution also enabled estimation of the likelihood that the European Commission's 'tolerance' for BSE-infected animals in a country with a GBR 1 rating (i.e. one animal per ten million head) would have been exceeded by the importation of infected animals. In probability terms, this equated to the likelihood that three or more infected animals were imported. A probability statement in this form (approximately 0.43%) was provided in a submission to the SSC, as a part of Australia's bid for classification as a GBR 1 country.

The results of the process are outlined in Table 4 below.

Table 4 Quantitative results

Source	Utility	Probability (X = x_I) infected animals		Probability ≥ 1 infected animal	Probability ≥ 3 infected animals
UK	Dairy	$X_I = 1$	0.0065	0.65%	0.00%
		$X_I \geq 2$	0.0000		
	Beef	$X_I = 1$	0.0001	0.01%	0.00%
		$X_I \geq 2$	0.0000		
	Dual Purpose	$X_I = 1$	0.0021	0.21%	0.00%
		$X_I \geq 2$	0.0000		
	All UK cattle			0.87%†	0.00%†
Europe	Beef	$X_I = 1$	0.9993	0.07%	0.00%
		2	0.0007		
		$X_I \geq 3$	0.0000		
	Dual Purpose	$X_I = 1$	0.9995	0.05%	0.00%
		2	0.0005		
		$X_I \geq 3$	0.0000		
	All European cattle			0.12%†	0.00%†
Total				**0.99%**†	**0.00%**†

† It is an artefact of probability theory that this 'overall' result does not equal the sum of the results obtained separately for UK and European cattle

Table 4 shows that there is a very low (approx 1%) likelihood that at least one infected animal may have entered the cattle slaughter system in Australia prior to the ban. It can also be seen that the likelihood that the European Commission's 'tolerance' for BSE-infected animals in a country with a GBR 1 rating (i.e. one animal per ten million head) would have been exceeded by the importation of infected animals alone, was effectively zero.

Conclusions: release assessment

From this phase of the investigation, it was concluded that the likelihood that one or more infected animals were imported and sent to slaughter before the ban is approximately 1%. This was qualitatively interpreted as a 'very low' likelihood. The model is extremely sensitive to incidence, such that the use of a single figure based on the overall population would have led to a probability distribution that is unrealistic. In other words, the history of the individual animals that make up the total population is critical. For this reason, UK investigations at Annex 2 are critical. They diminish the 'very low' likelihood further and make the figure of 1% a conservative upper limit.

Exposure assessment

The objective of the exposure assessment was to estimate the likelihood that the BSE infective agent would have established undetected within the Australian cattle herd, had at least one BSE-infected animal been imported and sent to slaughter before the ban on the inclusion of ruminant derived materials in ruminant feed.

In SSC parlance, this phase of the investigation equated loosely to an investigation of Australia's 'stability'. Stability is defined by the SSC as '... *the ability of a BSE/cattle system to prevent the introduction and to reduce the spread of the BSE agent within its borders* ...', and relies on '... *the avoidance of processing of infected cattle and the avoidance of recycling of the BSE agent via the feed chain* ...'. Under this terminology, the SSC maintain that '*a stable system would eliminate BSE over time*', and '*an unstable system would amplify it*'.

The SSC consider a country's 'stability' to be derived from several key factors, including practices or regulations regarding:

- the feeding of MBM to cattle
- the rendering of cattle-derived tissues
- the exclusion of particular tissues/organs from rendering.

The SSC also considered practices or regulations regarding the slaughter of 'fallen stock'[6], and characteristics of a country's surveillance for TSEs important to a country's 'stability'.

With these factors in mind, the exposure assessment was based on the following sequence of questions;

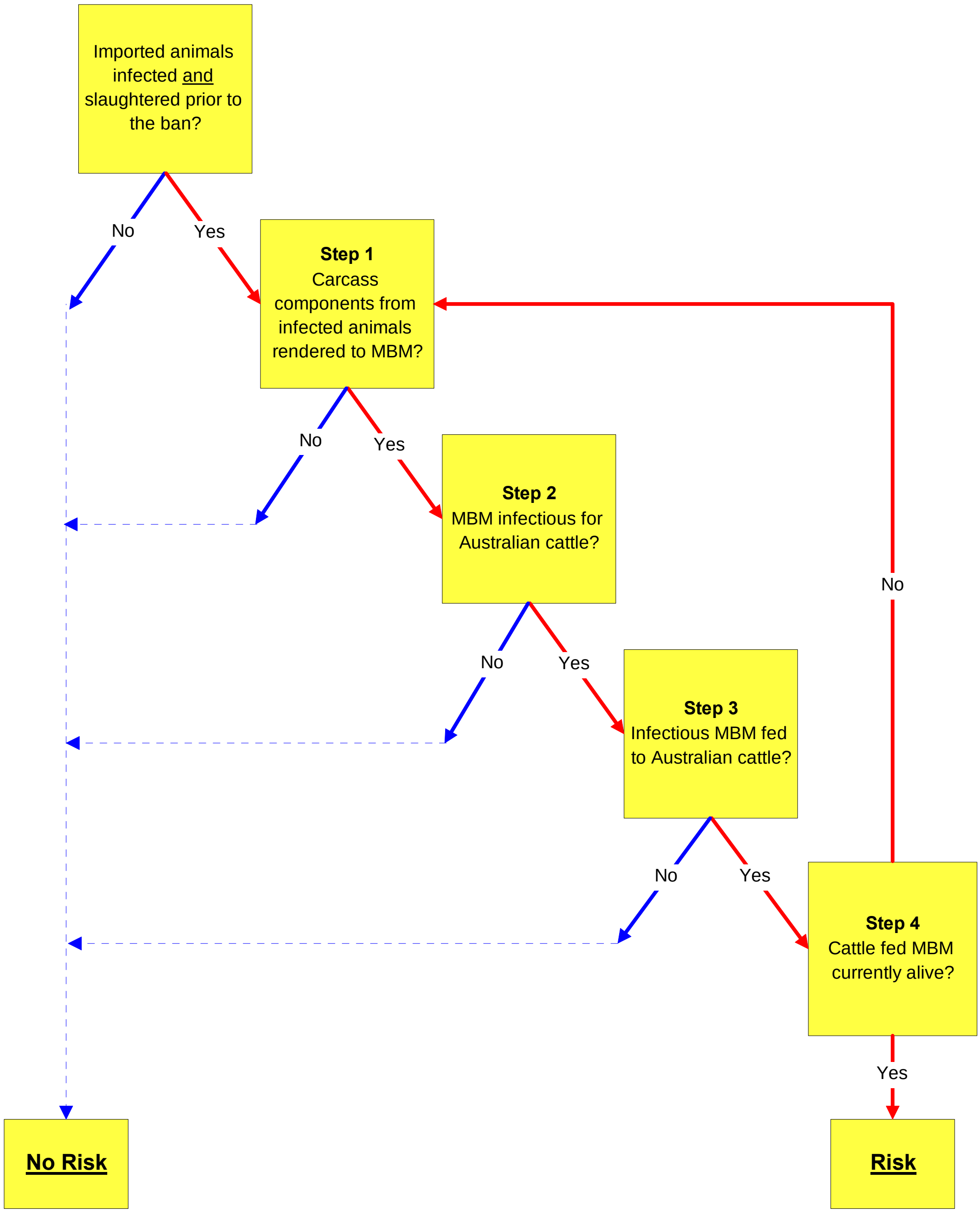
- would carcass components from a slaughtered infected (i.e. incubating or clinically affected) animal have been rendered to MBM?
- would MBM thus derived have been infectious for Australian cattle?
- would infectious MBM have been fed to Australian cattle?
- would Australian cattle fed infectious MBM remain alive and incubating the disease, or clinically affected but undetected by Australia's passive and active surveillance for BSE?

These questions, or steps, were viewed as risk-reducing factors, each of which would have contributed in a 'multiplicative' sense to final likelihood the BSE infective agent established within the Australian cattle herd, were an infected (incubating or clinically affected) animal imported and sent to slaughter (Figure 1).

The four steps are discussed individually.

[6] 'Fallen stock' are recumbent or seriously debilitated animals.

Figure 1 Steps in the exposure assessment



Step 1 - Would carcass components from a slaughtered infected animal have been rendered to MBM?

It can be assumed that at least some of the carcass components from any animal that was slaughtered in Australia would have been rendered to MBM.

Step 2 - Would MBM have been infectious for Australian cattle?

Three issues were considered relevant to this question;

1. the efficacy of Australian rendering systems as regards inactivation of the BSE infectious agent
2. the carcass components commonly rendered to MBM
3. the titre of BSE infectious agent in rendered carcass components

The efficacy of rendering in Australia. Processes employed by the 119 registered Australian rendering establishments are summarised below (European Commission, 2000; AFFA, 2000b);

- *Batch dry rendering*. Sixty of the Australian establishments use batch dry rendering, with conditions differing in accordance with the type of material to be processed. Typically, the lowest temperature for mixed raw material (including soft material) is approximately 120^0C, while the highest is approximately 145^0C. Cooking time ranges between 70 and 140 minutes.
- *Continuous dry rendering*. Forty of the Australian establishments use continuous dry rendering, with conditions differing in accordance with the type of material to be processed. Typically, the lowest temperature for mixed raw material (including soft material) is approximately 125^0C, while the highest is approximately 136^0C. Cooking time ranges between 35 and 90 minutes.
- *Continuous wet rendering*. Nineteen of the Australian establishments use various continuous wet rendering systems. The highest temperature for tallow is approximately 100^0C. Cooking time varies with the configuration of particular system and, in particular, with the addition of steam under pressure.
- *Processing in accordance with the EU standard*. Eight of the Australian establishments can transform ruminant material into MBM in accordance with the EU standard (batch conditions at 133°C, 3bar, 20min). Three of these are approved to export to the EU.

The European Commission's *Report on the Assessment of the Geographical BSE Risk of Australia* concluded that since not more than 3% of Australian rendering complies with the current EU standard, and because much of this portion is subsequently exported, Australian MBM should be classified as potentially infective. This extremely conservative position is likely to underestimate the complexity of the situation in Australia, where rendering in accordance with the range of protocols outlined above would be expected to lead to a reduction in the titre of the BSE infective agent, if not its complete inactivation. Indeed, in the report of the British Government's Review Committee (Review Committee, 2001) it is explained that;

- no rendering system will completely inactivate the BSE infective agent in MBM
- alteration of rendering practices in the UK prior to the BSE outbreak (specifically, the switch from batch to continuous processing and the removal of solvent extraction of tallow[7]) was likely to have added an 'enabling' effect to the dynamics of infection - that is, that while rendering practices in the UK prior to, and during, the 1970s would not have been completely effective in inactivating the BSE infective agent, they would probably have reduced its titre below the 'threshold' required for infection of 'susceptible' animals.

The Review Committee further qualified this by citing experimental evidence (Taylor et al, 1997) that suggested that alterations to rendering in the UK would have led to a reduction in the inactivation of the BSE infective agent of approximately the same magnitude as required mathematically to produce the rate of infection observed in the UK epidemic. Given that rendering practices in Australia prior to

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[7] According to the Review Committee, it is a common misconception that reduction in temperature or failure to prescribe minimum holding times in the rendering of carcass waste led to the failure of inactivation of the scrapie agent and transmission across the species barrier to cattle.

the ban were at least comparable to those in the UK prior to, and during, the 1970s, it is reasonable to assume that the conclusions of the Review Committee would apply equally to the Australian situation - *viz,* that such practices are likely to have provided a ‘degree of inactivation’ sufficient to prevent infection, should livestock have been fed MBM derived from a BSE-infected carcass.

<u>The carcass components commonly rendered to MBM</u>. It is known that the so-called specified risk materials (SRMs) such as central nervous system (CNS) tissue (e.g. brain, brainstem and spinal cord) and the intestine[8] are generally the components of a carcass that are rendered in Australia. It is also known, however, that mixing of SRMs and low risk materials, and of the carcass materials from different animals, is an integral feature of the rendering process.

The impact of thorough mixing in the context of Australian rendering plants is not clearly understood. On the one hand, mixing may have resulted in the subsequent exposure of a larger number of cattle. Alternatively, however, mixing would have led to a substantial dilution effect, as the ‘proportion’ of infected animals (should they have existed) would have been extremely low. In fact, since the likelihood that more than a single infected animal would have been imported and slaughtered in Australia is virtually zero, this proportion would most probably have been ‘one over the very large number of animals processed in any day or run in an Australian meatworks’. In view of this, and of the additional mixing of SRMs and low risk carcass components, it can be seen that a dilution in the titre of infected material of at least several orders of magnitude would be expected.

Dilution equates intuitively to a reduction in the amount of infectious agent in MBM likely to have been consumed by any one animal. Whether the amount fed may still have exceeded the ‘threshold’ for infection discussed by the Review Committee (see above) cannot be determined. What can be said, however, is that dilution of this magnitude was not a feature of the situation in the UK prior to the BSE epidemic, where (a) a much higher proportion of animals were infected, and, (b) carcass components from a much smaller number of animals were generally rendered into any one batch of MBM.

<u>The titre of BSE infectious agent in rendered carcass components</u>. It is extremely *unlikely* that an animal exhibiting the symptoms of clinical BSE would have satisfied the ante-mortem inspection procedures routinely carried out in all Australian abattoirs. In other words, an infected animal that entered the cattle slaughter system in Australia would almost certainly have been incubating the disease, rather than expressing it clinically.

Research carried out in the UK (Wells et al, 1994; Wells et al, 1998; Wells et a, 1999) showed that tissue extracts from the small intestine of calves were infective to mice within 6-18 months after oral inoculation. Extracts from the bone marrow were infective 38 months after inoculation. However, the same studies also showed that tissue extracts from the CNS tissues were *not* infective until the onset of clinical illness. In other words, the tissues most likely to be relevant in the Australian context and in incubating animals, are not from the nervous system, but from the small intestine, particularly, the distal ileum (Wells et al, 1998). All studies on infectivity are conveniently summarised in the report of the British Food Standards Agency (FSA, 2000),

While the titre of infective agent in the ileum of incubating animals is likely to vary amongst animals, and with the stage of the disease, it is also likely to be substantially lower than the titre of infective agent associated with the CNS tissues of clinically affected animals. Moreover, the intestinal tissue component of carcass materials rendered to MBM is likely to be a very small proportion of the overall rendered mass. These factors would lead to a substantial dilution effect, over-and-above that which

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[8] From January 1 2001, the entire intestine was added to UK national legislation regarding SRMs derived from cattle of any age.

was attributed to 'mixing' of carcass components from different animals (see above). While it cannot be determined whether the resulting titre might still exceed the 'threshold' for infection, it is clear that rendering of incubating animals only was not a feature of the situation in the UK prior to the BSE epidemic.

Summary

When the three issues associated with rendering were combined, it was considered very unlikely that MBM derived from an infected imported animal would have been infectious for Australian cattle.

Step 3 - Would infectious MBM have been fed to Australian cattle?

Table 5 summarises the production and utilisation of MBM in Australia between 1980 and 1998. Significantly, it can be seen that for much of this period a very small proportion (approx 1-2%) of MBM produced in Australia was utilised in cattle feed, whether directly or as a component of commercially produced feeds. The balance (approx 98-99%) was incorporated into pig, poultry and pet foods, or used as fertiliser.[9]

The proportion of MBM utilised in cattle feed increased to 4-6% during the period 1990 to 1994. The increase was most marked in dairy cattle, as drought conditions over much of Australia's eastern seaboard had reduced the availability (and increased the price) of alternative protein sources. A parallel (though less marked) increase in beef cattle is believed to reflect; (a) a similar response to the urgent need for drought feed, (b) a trend for export beef feedlots, and, (c) the practices adopted by extensive beef farmers in New South Wales and Queensland to include MBM as a routine component of the ration (AFFA, 2000c). There is no evidence to suggest that MBM was fed preferentially to dairy or beef calves, as was the case in the UK prior to the BSE epidemic.

A voluntary ban on the use of ruminant material in ruminant feed was instigated in 1996, prompting distributors of MBM and manufacturers of commercial cattle feeds to report zero utilisation for that year. It was reported in Australia's submission to the SSC that compliance with the ban was upheld rigorously by members of rendering associations. All feeding of MBM to cattle ceased with the instigation of the official ban in October 1997.

[9] Personal communication — Australian Stockfood Manufacturers Association, 2001.

Table 5 Production and utilisation of meat and bone meal in Australia in tonnes†

Year	Total	Dairy cattle	Beef cattle	Commercial cattle feed[10]	Total cattle (%)
1980 - 1981	327,537	< 1,000	< 1,000	< 1,000	< 3,000 (1%)
1981 - 1982	344,722	< 2,000	< 1,000	< 1,000	< 4,000 (1%)
1982 - 1983	384,044	< 2,000	< 1,000	< 1,000	< 4,000 (1%)
1983 - 1984	322,198	< 2,000	< 1,000	< 1,000	< 4,000 (1%)
1984 - 1985	341,555	< 2,000	< 1,000	< 1,000	< 4,000 (1%)
1985 - 1986	372,098	< 4,000	< 2,000	< 1,000	< 7,000 (2%)
1986 - 1987	402,342	< 6,000	< 2,000	< 1,000	< 9,000 (2%)
1987 - 1988	417,744	< 8,000	< 2,000	< 1,000	< 11,000 (3%)
1988 - 1989	386,849	< 1,0000	< 2,000	< 2,000	< 5,000 (1%)
1989 - 1990	466,871	< 1,0000	< 2,000	< 2,000	< 5,000 (1%)
1990 - 1991	480,718	< 12,000	< 3,000	< 2,000	< 17,000 (4%)
1991 - 1992	479,973	< 15,000	< 3,000	< 2,000	< 20,000 (4%)
1992 - 1993	468,397	< 18,000	< 4,000	< 2,000	< 24,000 (5%)
1993 - 1994	453,536	< 21,000	< 4,000	< 3,000	< 28,000 (6%)
1994 - 1995	467,500	< 2,000	< 5,000	< 3,000	< 10,000 (2%)
1995 - 1996	423,500	< 5,000	< 1,000	< 1,000	< 7,000 (2%)
1996 - 1997	407,000	0	0	0	0
1997 - 1998	434,500	0	0	0	0

† Source: Australian Stockfood Manufacturers Association

Summary

For much of the period of interest to this investigation, it would have been very unlikely for infective material that entered the MBM system through the slaughter of an incubating animal to have subsequently been fed to Australian cattle. Indeed, the odds of this event occurring are approximately one in fifty. This likelihood increased somewhat during the period of enhanced feeding of MBM (1990 to 1994) although was never higher than approximately 6% — an odds of approximately one in fifteen.

[10] The term ‘commercial cattle feed’ is used to describe pelleted and other processed feeds. By comparison, the utilisation of MBM as food for ‘dairy cattle’ and ‘beef cattle’ implies its inclusion on-farm or in feedlots as a variable component of a ration.

Step 4 - Would Australian cattle fed infectious MBM remain alive and incubating the disease, or clinically affected but undetected by Australia's passive and active surveillance for BSE?

In order for cattle fed MBM that contained the BSE infective agent to affect Australia's BSE status they must currently be alive and, thus, a part of the national herd. Since BSE has not been diagnosed in Australia, these animals must also either; (a) be incubating the disease, or, (b) have become clinical cases but have eluded Australia's active and passive surveillance for BSE.

Three issues were relevant to this step in the assessment;

1. the survival profile of Australian cattle
2. the incubation period for BSE
3. Australia's passive and active surveillance for BSE

<u>The survival profile of Australian cattle</u>. Since the period of increased utilisation of MBM in cattle feed ran from approximately 1990 to 1994 (ie 6-10 years prior to the drafting of this report), it is apparent that most cattle fed MBM during that time will have been slaughtered or will have died on-farm. More specifically, *all* cattle that were in beef feedlots during that period will have been slaughtered (largely for export), while most dairy cattle will have exceeded the age of optimal productivity and economic return and are likely to have been culled. Some extensively farmed beef store cattle may remain alive, although the proportion slaughtered or otherwise dying each year will be increasing. Each of these statistics would be further reduced for animals exposed to the BSE infectious agent before 1990.

<u>The incubation period for BSE</u>. The incubation period for BSE appears to depend on a raft of poorly defined factors, but falls in most cases between 3 and 8 years (Wilesmith et al, 1988; Anderson et al, 1996). Thus, it is reasonable to expect that most animals infected during or before the period of enhanced feeding of MBM (1990 to 1994) and currently alive, would have developed clinical symptoms. Those infected before this period would almost certainly have developed clinical symptoms.

<u>Australia's passive and active surveillance for BSE</u>. Ten years have passed since the start of the period of increased utilisation of MBM in cattle feed (1990) and, throughout these, the Australian cattle herd has received vigorous active and passive surveillance.

The chronology of Australian surveillance for scrapie and BSE is summarised below.

Scrapie

- A program of active surveillance for scrapie was implemented following an incursion of this disease in 1952. The program included 16 years of detailed monitoring of the property on which the outbreak occurred, and of surrounding properties.
- Since the incursion of scrapie in 1952, the histopathology of brains of sheep showing neurological signs has been an element of passive surveillance for scrapie. In the years between 1952 and 1981, over 2000 brains from throughout Australia were submitted for examination. No evidence of scrapie has been found.
- Australian sheep are examined routinely during the course of ante-mortem inspection at abattoirs, live export certification and saleyards inspections. During the period 1987 to 1997, approximately 30 million adult sheep and lambs were inspected and slaughtered. Between 1993 and 1997, over 26 million sheep were inspected and exported. No evidence of scrapie has been found as a result of these inspections.

BSE

- Before 1990, passive surveillance for BSE in Australia was based on the observations of skilled government and private veterinarians, as well as those of informed owners and handlers of stock. BSE was considered in the differential diagnosis of all bovine neurological disease. Brains submitted for histopathology were examined for evidence of BSE. No evidence of BSE was found.
- In 1990, an active surveillance program for BSE involving the examination of cattle brains was implemented. The number of cattle brains examined for histopathological evidence of BSE during various subsets of this period is shown in Table 6 below. During this time, passive surveillance through the differential diagnoses of veterinarians and the observations of the farming community continued. No evidence of BSE was found.

Table 6 Laboratory surveillance for BSE *prior to* the National TSE Surveillance Program (1998)

State / Territory	Period	Bovine brains examined
Tasmania	1992-1996	180
Western Australia	1990-1995	104
Victoria	1990-1995	600
New South Wales	1991-1995	1200
Queensland	1990-1996	957
South Australia	1991-1995	257
Northern Territory	Since 1/1/95	21
Total		**3319**

- Since 1994 BSE has been **compulsorily notifiable** in Australia.
- In 1998, a **National TSE Surveillance Program** (NTSESP) was implemented. The NTSESP is an integrated national program jointly funded by industry and governments and managed by the Australian Animal Health Council (AAHC). The NTSESP complies with the OIE Code chapter on BSE, which requires that countries claiming to be free of TSEs have in place a surveillance system to detect BSE and scrapie, should they occur.

The key outputs of the program are:

- examination of sufficient cases of nervous disease and chronic progressive disease or wasting in cattle and sheep through laboratory examination or treated and recovered reports to satisfy Australia's TSE surveillance targets
- an easily accessible and up-to-date national database of TSE surveillance information supported by detailed, eligible case records and laboratory specimens stored for at least 7 years — publication of results from TSE surveillance in Animal Health Surveillance Quarterly, the web site of the National Animal Health Information System (NAHIS) program and in Animal Health in Australia
- provision of information from TSE surveillance to support trade in Australia's livestock products and assure domestic consumers of beef and sheep meats of Australia's freedom from TSE in food animals.

Each State and Territory animal health agency, together with AQIS, participates in the NTSESP with a national coordinating role provided through the NAHIS (National Animal Health Information System) Coordination Group. Awareness and training programs on TSE surveillance are carried out through industry peak bodies, State and Territory animal health agencies and AQIS. A financial incentive scheme has been developed to increase reporting and investigation of eligible TSE cases by producers and private veterinarians.

Private veterinarians and officers of the State and Territory animal health agencies and AQIS, through existing networks, carry out clinical and/or post-mortem examination of eligible cases. Specimens are accompanied by a detailed case history. Initial histopathological examination of brains to specifically exclude a TSE is performed by pathologists trained in TSE diagnostic techniques — if required, further diagnostic investigations are undertaken by trained personnel located at Australian Animal Health Laboratory. The TSE surveillance program complies with the current OIE International Animal Health Code, in which it is stated that the number of samples taken each year should be based on a 99% probability of detecting BSE, if the disease accounts for 1% of the cases of neurological disease in cattle.

The number of eligible cases of neurological disease in cattle and sheep requiring examination each year under the NTSESP is shown in Table 7 below. According to the OIE rationale, 400 cattle brains should be examined each year. Australia exceeds this number (489 cattle brains were examined in 1999) and targets specific sub-populations considered to be of a higher risk of BSE.

No evidence of BSE has been found in Australia.

Table 7 Number of eligible cases required to be examined each year under the National TSE surveillance program

State / Territory	Number of cases to examine each year	
	Cattle	Sheep
Queensland	156	40
New South Wales	100	153
Victoria	68	81
Tasmania	12	14
South Australia	16	50
Western Australia	24	112
Northern Territory	24	0
Total	**400**	**450**

- In addition to the NTSESP, passive surveillance through the differential diagnoses of government and private veterinarians, and the observations of the farming community, has continued. The level of training and awareness of both groups as regards neurological diseases of cattle and sheep has increased in step with the attention BSE has received internationally.

Risk assessment: BSE and the Australian cattle herd

Summary

It was stated at the start of this discussion that in order for cattle fed MBM that contained the BSE infective agent to affect Australia's BSE status they must currently be *alive* and, thus, a part of the national herd. Since BSE has not been diagnosed in Australia, these animals must also either; (a) be incubating the disease, or, (b) have become clinical cases, but have eluded Australia's active and passive surveillance for BSE.

From this, it was shown that;

- most animals fed MBM of ruminant origin before the ban (1996) and, more importantly, during the period of enhanced feeding (1990 to 1994), would have died or have been culled by the year 2001
- *if* Australian cattle were infected prior to 1996 (more importantly, between 1990 and 1994), it is very likely that most would have become clinical cases by the year 2001
- *if* Australian cattle were infected and became clinical cases, they would almost certainly have been detected through ongoing passive and active surveillance for TSEs

Conclusions: exposure assessment

The objective of the exposure assessment was to estimate the likelihood that the BSE infective agent would have established undetected within the Australian cattle herd, if at least one BSE-infected animal had been imported and sent to slaughter before the ban. The assessment was based on the following four questions, each of which *must* have been answered affirmatively for establishment within the Australian cattle herd to have taken place;

4. would carcass components from a slaughtered infected (incubating or clinically affected) animal have been rendered to MBM?
5. would MBM thus derived have been infectious for Australian cattle?
6. would infectious MBM have been fed to Australian cattle?
7. would Australian cattle fed infectious MBM be incubating the disease, or be clinically affected but undetected by Australia's passive and active surveillance for BSE?

In answer to the *first* question, it was explained that at least some carcass components from all animals slaughtered in Australia are rendered to MBM.

Three issues were considered in answering the *second* question;

- the efficacy of Australian rendering systems as regards inactivation of the BSE infective agent
- the carcass components commonly rendered to MBM
- the titre of BSE infectious agent in rendered carcass components

These issues were considered in the light of the report of the British Government's Review Commission, where 'enabling' factors were described as key issues in the epidemiology of the UK BSE epidemic. In particular, the report described a 'threshold' titre of BSE infective agent in MBM that was most probably breached by a combination of altered rendering practices. The effect of the increased titre was subsequently exacerbated by the enhanced feeding of MBM to (notably) dairy calves.

When carried into the Australian context, this assessment showed that the titre of BSE infective agent in MBM was likely to have been substantially lowered by; (a) each of the various rendering practices used in Australia, (b) the degree of dilution that would have occurred in Australia if carcass components a single infected animal had been combined with a large number of uninfected animal, and, (c) the additional dilution that would have resulted from localisation of infection within the small intestine of incubating animals. Overall, the likelihood that MBM derived from an infected animal would have been infectious to Australian cattle was considered very low.

In answering the *third question*, the pattern of consumption of MBM in Australia prior to the ban was used to show that had infectious MBM been obtained from imported animals, it is very unlikely to have subsequently been fed to Australian cattle.

The *fourth* question was addressed by considering the survival profile of Australian cattle, the incubation period for BSE and Australia's passive and active surveillance for BSE. Here it was shown that *if* Australian cattle had been infected through the feeding of infectious MBM prior to the ban, it is very unlikely that they would remain both alive and incubating the disease. Given this, it was also shown that clinical cases of BSE would almost certainly have been detected through the range of passive and active surveillance systems in place in Australia. Most recently, this includes the NTSESP, which meets the requirements for certification of ongoing freedom from BSE outlined in the OIE Code.

When the responses to these four questions were viewed in the context of a pathway of 'necessary' steps, the overall likelihood that BSE would have established undetected in the Australian cattle herd, had at least one infected animal entered the cattle slaughter system was considered negligible.

Assessment of overall risk

The objective of this study was to investigate the likelihood that BSE became established within the Australian cattle herd as a result of the importation of 204 cattle from the UK (1980 to 1988) and 289 cattle from Europe (1987 to 1991). The underlying premise was that in order to become established, the BSE infective agent was recycled through the feeding of MBM derived from infected imported animals. Subsequent recycling of infected Australian cattle through the same MBM system might then have led to amplification of the disease and its possible establishment in the cattle population.

The investigation was carried out in two phases.

> <u>The release assessment</u>: a *quantitative* assessment of the likelihood that at least one infected animal entered Australia, and was subsequently slaughtered, prior to the instigation of a ban on the inclusion of ruminant materials in ruminant feed. This assessment was based on the published scientific literature on the epidemiology of BSE in the UK and Europe, and on quarantine station records, surveillance records and stud records describing the origin, importation details, management and (where relevant) disposal of imported animals.
>
> <u>The exposure assessment</u>: a *qualitative* assessment of the likelihood that the BSE infective agent would have established within the Australian cattle herd, if at least one BSE-infected animal had been imported and sent to slaughter before the ban. This assessment was based on an examination of the 'pathway' of steps, or events, necessary for infection to have been disseminated undetected from the carcass of an infected imported animal to the Australian cattle herd.

From the release assessment it was found that the likelihood that one or more infected animals were imported and entered the cattle slaughter system is approximately 1%. This qualitatively interpreted as a very low likelihood. From the exposure assessment it was found that the likelihood that that BSE would have established undetected in the Australian cattle herd, had at least one infected animal entered the cattle slaughter system, was negligible. When the two results were considered together, the overall likelihood that BSE became established within the Australian cattle herd as a result of the importation of cattle from the UK and Europe was also described as negligible.

The importance of this result is the support it lends to Australia's case for classification as a Category 1 country. BSE has never been observed in Australia and, despite the importation of cattle from the UK and Europe, it is clear that Australia remains free from what is an important trade-limiting animal disease.

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Release assessment: all animals imported from the UK and EU since 1980

Row	Numbers of cattle: Beef	Dairy	Dual	Total	Birth cohort	Cumulative incidence: % overall	Beef	Dairy	Dual	"Expected" number of infected cattle: Beef	Dairy	Dual	All cattle
9						**Cattle from UK**							
11	1	0	0	**1**	76/77	0.0066	0.0010	0.0087	0.0010	0.0000	0.0000	0.0000	0.0000
12	0	0	0	**0**	77/78	0.0227	0.0034	0.0299	0.0034	0.0000	0.0000	0.0000	0.0000
13	0	0	0	**0**	78/79	0.0238	0.0035	0.0314	0.0035	0.0000	0.0000	0.0000	0.0000
14	1	0	0	**1**	79/80	0.0696	0.0103	0.0917	0.0103	0.0001	0.0000	0.0000	0.0001
15	0	0	0	**0**	80/81	0.0933	0.0139	0.1230	0.0139	0.0000	0.0000	0.0000	0.0000
16	0	2	0	**2**	81/82	0.2490	0.0370	0.3282	0.0370	0.0000	0.0066	0.0000	0.0066
17	0	0	0	**0**	82/83	0.7582	0.1126	0.9994	0.1126	0.0000	0.0000	0.0000	0.0000
18	0	0	1	**1**	83/84	1.4077	0.2091	1.8554	0.2091	0.0000	0.0000	0.0021	0.0021
19	0	0	0	**0**	84/85	1.8647	0.2769	2.4578	0.2769	0.0000	0.0000	0.0000	0.0000
20	0	0	0	**0**	85/86	2.7655	0.4107	3.6451	0.4107	0.0000	0.0000	0.0000	0.0000
21	0	0	0	**0**	86/87	4.7593	0.7068	6.2730	0.7068	0.0000	0.0000	0.0000	0.0000
22	0	0	0	**0**	87/88	5.3867	0.8000	7.1000	0.8000	0.0000	0.0000	0.0000	0.0000
23	**2**	**2**	**1**	**5**						**0.0001**	**0.0066**	**0.0021**	**0.0088**
25						**Cattle from the EU**							
27	20	0	23	43	85/86	0.0013	0.0010	0.0089	0.0010	0.0002	0.0000	0.0002	0.0004
28	0	0	0	0	86/87	0.0022	0.0017	0.0153	0.0017	0.0000	0.0000	0.0000	0.0000
29	16	0	1	17	87/88	0.0024	0.0020	0.0173	0.0020	0.0003	0.0000	0.0000	0.0003
30	11	0	27	38	88/89	0.0011	0.0009	0.0076	0.0009	0.0001	0.0000	0.0002	0.0003
31	13	0	2	15	89/90	0.0005	0.0004	0.0038	0.0004	0.0001	0.0000	0.0000	0.0001
32	**60**	**0**	**53**	**113**		5.3867	0.8000	7.1000	0.8000	0.0007	0.0000	0.0005	0.0012
33													0.0099

Row	Cases imported	UK Cattle: Beef	Dairy	Dual	Total	EU Cattle: Beef	Dual	Total	Total
37	0	0.9999	0.9935	0.9979	0.9913	0.9993	0.9995	0.9988	0.9901
38	1	0.0001	0.0065	0.0021	0.0087	0.0007	0.0005	0.0012	0.0098
39	2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
40	3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
41	4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
42	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
44	**Probability (one or more BSE infected animal was imported) =**	**0.01%**	**0.65%**	**0.21%**	**0.87%**	**0.07%**	**0.05%**	**0.12%**	**0.99%**
45	**Probability (three or more BSE infected animal were imported) =**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Cell formulae

F23 = SUM(F11:F12) ... rpt G23:I23
M11 = $L11*M$32/$L$32 ... rpt M12:M22
N11 = $L11*N$32/$L$32 ... rpt N12:N22
O11 = $L11*O$32/$L$32 ... rpt O12:O22
Q11 = F11*M11/100 ... rpt Q12:Q22
R11 = G11*N11/100 ... rpt R12:R22
S11 = H11*O11/100 ... rpt S12:S22
T11 = SUMPRODUCT(F11:H11,M11:O11)/100 ... rpt T12:T22
F32 = SUM(F27:F31)
G32 = SUM(G27:G31)
H32 = SUM(H27:H31)
I32 = SUM(I27:I31)
Q32 = SUM(Q27:Q31)
R32 = SUM(R27:R31)
S32 = SUM(S27:S31)
T32 = SUM(T27:T31)
T33 = T32+T23
L37 = POISSON(K37,Q23,0) ... rpt L38:L42
M37 = POISSON(K37,R23,0) ... rpt M38:M42
N37 = POISSON(K37,S23,0) ... rpt N38:N42
O37 = POISSON(K37,T23,0) ... rpt O38:O42
P37 = POISSON(K37,Q32,0) ... rpt P38:P42
Q37 = POISSON(K37,S32,0) ... rpt Q38:Q42
R37 = POISSON(K37,T32,0) ... rpt R38:R42
T37 = POISSON(K37,T33,0) ... rpt T38:T42
L44 = 1-L37 ... rpt M44:T44
L45 = 1-(L37+L38+L39) ... rpt M45:T45

ANNEX 2

RESULTS OF BACKTRACING OF CATTLE IMPORTED FROM THE UNITED KINGDOM BETWEEN 1980 AND 1988

Efforts were made to backtrace all cattle imported from the UK to their farms of origin and to determine the BSE history of these farms of origin and involved:

- Department for Environment Food and Rural Affairs, Page Street, London,
- Veterinary Laboratory Service at Central Veterinary Laboratory, Weybridge,
- States of Jersey Department of Agriculture and Fisheries,
- Isle of Man Department of Agriculture, Fisheries and Forestry, and
- Various cattle breed societies in the UK.

1 Dairy Cattle

Sixty-two dairy cattle were imported into Australia comprising 33 Friesians, 26 Jerseys and 3 Guernseys.

1.1.1 1.1 Friesians

All Friesians were imported by a dairy farmer who migrated to Australia in 1980. He imported 29 heifers, 2 cows and 2 bulls, some of which came from his herd which was dispersed just before he moved to Australia with the rest coming from three other herds in other parts of the UK. This farmer kept very good records as to how and when these cattle were disposed of after they arrived in Australia. The breakdown of the imports and what happened to these cattle are as per Table 2 (next page).

Only two cattle originating from a farm in Essex where BSE has been reported have entered the food chain. Table 1 provides more detailed information of these two cattle.

Table 8 Table 1 Friesian cattle from farms where BSE was recorded and slaughtered in Australia under 120 months of age

Sex	Date of birth	Date sold for slaughter	Age at slaughter	Date of birth of BSE index case on farm of origin	Period from date of birth to BSE index case	Reason for slaughter
F	7/9/81	22/9/87	72 mths	6/7/83	21 mths	Daughters were not of high enough standards.
F	30/11/81	10/9/87	69 mths	6/7/83	19 mths	Inferior udder

Table 9 Table 2 Importation of Friesian cattle

Farm of origin	BSE History	Date of import	Number of cattle imported	Date of birth of imported cattle	Method of disposal	Number of cattle	Age range of cattle
Derbyshire	No record of BSE in cattle bred by the owners before they migrated to Australia.	29/9/1980	15	7/10/77 to 24/11/79	Died on farm	5	38 to 172 mths
					Slaughtered >10yrs of age	9	123 to 198 mths
					Slaughtered <10yrs of age	1	106 mths
Staffordshire	11 cases of BSE recorded in cattle bred by owners of official identification of these cattle. Index case was born on 13/4/84.	29/9/1980	4	10/12/78 to 24/11/79	Died on farm	1	37 mths
					Slaughtered >10yrs of age	1	192 mths
					Slaughter scheme 1997	2	206 to 217 mths
Suffolk	30 cases of BSE recorded in cattle bred by owners of official identification of these cattle. Index case was born on 3/12/84.	29/9/1980	3	2/3/79 to 29/12/78	Slaughtered >10yrs of age	3	133 to 144 mths
Essex	28 cases of BSE recorded in cattle bred by owners of official identification of these cattle. Index case was born on 6/7/83.	29/9/1980	3	20/3/79 to 19/12/78	Died on farm	1	176 mths
					Slaughtered >10yrs of age	2	133 to 149 mths
		4/10/82	8	25/3/81 to 18/2/82	Died on farm	2	30 to 53 mths
					Slaughtered >10yrs of age	4	137 to 176 mths
					Slaughtered <10yrs of age	**2**	**69 to 72 mths**

1.1.2 1.2 Jerseys

Four Australian Jersey dairy farmers imported all 26 Jerseys from the Jersey Island. These cattle were sourced from 15 farms, none of which have had BSE recorded. Jersey Island has reported 149 confirmed cases of BSE to date. The disease was first confirmed on the island on 24 January 1989 and the earliest index case was born on 1 December 1982. As all Jersey cattle born on the island must be registered, the birth dates and farms of origin of all cases of BSE are known.

1.1.3 1.3 Guernseys

All three Guernseys were imported from the one farm in Somerset that had no record of BSE.

1.2 2 Beef cattle

Several breeds of beef cattle were imported from the UK as summarised in Table 3.

Table 10 Table 3 Summary of BSE history of farms of origin of beef cattle imported from the UK.

Breed of cattle	Number of cattle imported	Number of last known owners	Number of farms of origin in UK	Number of farms of origin where BSE has been recorded
Belgian Blue	6	3	2	0
Blonde D'Aquitaine	18	5	2	1
Chianina	5	2	1	0
Devon and Polled Devon	9	4	4	0
Hereford	31	15	8	2
Highland	6	4	5	0
Limousin	10	7	4	1
Lincoln Red	3	1	2	0
Longhorn	5	1	2	1*
Salers	8	3	1	0
South Devon	28	8	4	0
White Park	4	1	2	0

* the farm of origin is still to be confirmed by the cattle breed society.

1.2.1 2.1 Blonde D'Aquitaine

One animal, born on 25 June 1977 and whose fate is unknown, originated from a farm where

5 cases of BSE were recorded, the first two occurring in 1992. The date of birth is not known, but is likely to have been born during the mid-1980's.

As there is an interval of 15 years between the birth date of the imported animal and when BSE was first noted in cattle bred on the farm of origin, the risk of the imported animal being infected with BSE is negligible.

1.2.2 2.2 Hereford

Seven unidentified Herefords were imported from New Zealand on 7 April 1981. The owner of these cattle advised some of these cattle originated from England. A search of the Exports book at the Royal Hereford Society of cattle exported to New Zealand show that up to seven cattle born after 1 July 1976 and originating from five farms in the UK could have been re-exported to Australia. Cattle from three of the five farms in the UK had also been exported directly to Australia. BSE has not been recorded on the two remaining farms.

Four Herefords, born between 26 April 1975 and 24 September 1980 and at most two unidentified cattle imported via New Zealand on 7April 1981 originated from a farm where one case of BSE was recorded in a five-year-old cow in October 1992. All except one, which was slaughtered at the age of 156 months, were reported to have died on the farm. As there is an interval of at least 12 years between the birth date of the imported animal and when BSE was first noted in cattle bred on the farm of origin, the risk of the imported animal being infected with BSE is negligible.

One Hereford bull, born on 9 September 1979 and slaughtered before 1990, originated from a farm where 2 cases of BSE were confirmed in 1992. The dates of birth of these animals are not available. However, as the interval between the birth date of the imported animal and when BSE was first noted in cattle bred on the farm of origin is 13 years, the risk of the imported animal being infected with BSE is negligible.

1.2.3 2.3 Limousin

Three limousin cows, born between 1 February 1986 and 7 August 1986, originated from a farm where BSE was recorded under the name of a different owner. Of these three, two cows were still alive early 2001 and one cow was reported to have died on the farm before 1997. Two cases of BSE were reported in homebred cattle on the farm of origin in January and May 1999. These cattle were born on 7 April 1989 and 9 March 1988 respectively. Another animal, born on January 1987 and purchased as a 2-3 week old calf, was diagnosed with BSE on October 1991. In addition, two cattle, dates of birth unknown and whose eartags suggest they were not homebred cattle, were confirmed with BSE in late 1993.

The two cows still alive were imported 14 years ago and are 15 years old. As the incubation period for BSE range from 3 to 8 years, the probability of these cows being infected with BSE is negligible.

2.4 Longhorn

The farm of origin of the Longhorn cattle is yet to be confirmed. Preliminary research suggests the cattle came from a farm that had five cases of BSE between 1992 and 2000. Cases in 1998 and 2000 were born in 1992 and 1993 respectively. All Longhorns were reported to have died on the farm in Australia.

3 Dual-breed

Table 4 summarises the BSE history of the farms of origin of the imported dual-breed cattle.

Table 11 Table 4 Summary of BSE history of farms of origin of dual-purpose breed imported from the UK.

Breed of cattle	Number of cattle imported	Number of last known owners	Number of farms of origin in UK	Number of farms of origin where BSE has been recorded
British White	5	5	3	1
Dexter	3	2	1	0
Simmental	1	1	1	0

3.1 British White

Two animals, born on 1 April 1984 and 16 April 1984 and both imported on 13 November 1984, originated from a farm where two cases of BSE were recorded. The owner reported that both cases were orphaned as calves and fed milk replacer. The first, born in September 1984, died of BSE in December 1990 while the second, born on 3 October 1988 died of BSE in July 1993.

Of the two imported animals, one was reported to be still alive in early 2001 while the other was slaughtered sometime during 1994. As the the former is over 17 years of age and was imported nearly 17 years ago, the risk of this cow being infected with BSE is negligible. The latter was aged somewhere between 117 and 129 months when slaughtered. Being almost 10 years old at the earliest at the time of slaughter, the risk of this cow being infected with BSE is extremely low.