



Evaluation of Post Mortem Examination Procedures for Adult Sheep Slaughtered in New Zealand

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October 2010

Final

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Executive Summary

NZFSA has an on-going goal of establishing ante- and post-mortem meat examination procedures that are based on scientific evaluation and risk assessment.

This is a summary NZFSA report on the proposed post mortem examination procedures for the carcasses and viscera of adult sheep slaughtered in New Zealand. It provides an effective set of procedures that will continue to provide an equivalent level of performance for detection and removal of abnormalities of food safety and suitability importance. This set of procedures will also mitigate against any inadvertent cross contamination with zoonotic pathogens that might result from unnecessary carcass handling.

This review is drawn from several sources:

- Benchmarking against procedures used in other countries
- Scientific evaluation of likely outcomes from different post mortem inspection regimes, using the scientific literature and previous New Zealand scientific reports as references
- Detailed observation of current examination procedures
- Targeted trials in New Zealand where significant gaps in knowledge exist.

Since examination procedures for the carcasses of adult sheep have traditionally involved a high level of palpation in New Zealand, a review was undertaken of current adult sheep post mortem inspection standards in use in Australia, the United States (US), Canada and the European Union (EU). This revealed that New Zealand is the only country that carries forward a number of “traditional” procedures in this area i.e. routine palpation of the abdominal and thoracic cavities and joints of the hind and fore legs of the carcass, and the bile duct, diaphragm, oesophagus, pericardium and edible tongue amongst the viscera.

Only the US requires palpation of the back and sides of carcasses but not the pelvic, abdominal or thoracic cavities, while Canada requires only a visual examination of the carcass with routine palpation of the superficial carcass lymph nodes. It is noteworthy that the EU has never required routine palpation of the carcass of adult sheep, while Australia requires palpation of only some carcass lymph nodes, but provides the option for companies to excise and discard superficial carcass lymph nodes without inspection.

Hygiene management within modern meat processing establishments is a process that includes minimising carcass contamination from pelt removal onwards. This includes post mortem examination of carcasses which have been presented in an appropriate manner, and the making of dispositions with a

minimum of carcass handling. Further, there is a strong international move towards identification and removal of overt contamination and defects that pertain to suitability at locations on the dressing line other than the post mortem inspection stand, when processing efficiencies can be gained from such changes. These changes are designed to allow industry to share the responsibility for delivering carcasses that continue to meet an appropriate level of suitability and acceptance by our markets.

This summary report presents a scientific evaluation of ovine examination procedures that draws heavily from earlier detailed scientific work on lambs in New Zealand, and the findings from other countries, especially Australia. Where there were gaps in the scientific information needed, field trials were carried out e.g. for arthritis, *Cystercercus ovis*, caseous lymphadenitis (CLA) and forequarter contamination. The recommendations resulting from this work closely align New Zealand with best practices in our major trading partner countries. It should be noted that scientific evaluation of ovine post mortem procedures in New Zealand has resulted in the recommendation for palpation of the neck for injection site lesions, a procedure not carried out in other countries.

NZFSA will continue to monitor the performance and effectiveness of these recommended procedures as they are implemented throughout New Zealand.

These recommendations are made on the basis of carcass presentation requirements that include:

- removal of the tail, pizzles and fat curtain sufficient to enable adequate visual examination of the pelvic cavity
- abdominal wall being incised in a manner that adequately exposes the pelvic cavity.
- the brisket is required to be split

Recommendations for change to the current post mortem examination procedures for adult sheep, taking into account the end use of the product, are summarised in the following tables. Routine removal of specified superficial lymph nodes prior to post mortem examination is recommended as an alternative to presentation and routine examination of these lymph nodes.

Table 1: Recommended examination procedures for adult sheep tissues intended for human consumption (edible)

Tissue	Viewing		Palpation	
	Current	Recommended	Current	Recommended
Abdominal cavity	V	V	P	P *
Back of carcass	V	V	P	
Bile duct	V	V	P	P *
Bronchial Inn	V	V	P	P * §
Diaphragm	V	V	P	P *
Forelegs	V	V		
Front of carcass	V	V		
Gastro-intestinal tract	V	V		
Head	V	V		
Heart	V	V	P	P *
Hepatic Inn	V	V	P	
Iliac Inn	V	V		
Ischiatic Inn		V	P	
Joints	V	V	P	
Kidneys	V	V	P	
Liver	V	V	P	P
Lungs	V	V	P	P * §
Mediastinal Inn			P	P * §
Mesenteric Inn	V	V	P	
Neck	V	V		P
Oesophagus	V	V	P	
Omental fat	V	V		
Pancreas	V	V		
Pelvic cavity	V	V		
Pericardium	V	V	P	
Peritoneum, visceral	V	V		
Pizzle	V	V	P	
Popliteal Inn			P	P*
Rectal cavity	V	V		
Spleen	V	V	P	
Subiliac Inn	V	V †	P	
Superficial cervical Inn		V †	P	P* †
Superficial inguinal Inn	V	V †	P	
Supramammary Inn	V	V †	P	
Testicles	V	V	P	P*
Thoracic cavity	V	V	P	
Thymus	V	V		
Tongue	V	V	P	
Trachea	V	V		

* for suitability purposes

† possibility of routine removal without examination

§ when lungs are saved as edible

Table 2: Recommended examination procedures for adult sheep viscera not intended for human consumption (inedible)

Tissue	Viewing		Palpation	
	Current	Recommended	Current	Recommended
Bile duct	V	V	P	
Bronchial Inn	V		P	
Diaphragm	V	V	P	
Gastro-intestinal tract	V	V		
Heart	V	V	P	
Hepatic Inn	V	V	P	
Kidneys	V	V	P	
Liver	V	V	P	
Lungs	V	V	P	
Mediastinal Inn			P	
Mesenteric Inn	V	V	P	
Pancreas	V			
Pericardium	V		P	
Spleen	V	V	P	
Trachea	V			

1 The current situation

1.1 Modernisation of ovine post mortem examination procedures in New Zealand

NZFSA has an on-going goal of establishing ante- and post-mortem meat examination procedures that are based on scientific evaluation and risk assessment. Risks to public health associated with consumption of red meat are an important modern food safety issue and serious outbreaks of disease associated with consumption of contaminated red meat have been documented in several countries in recent years.

Regulatory meat examination procedures should be primarily designed to protect consumers from hazards of public health significance. Food animals may be infected by zoonotic microorganisms which can cause clinical signs *ante-mortem* and/or lesions detectable *post-mortem*, however animals may also carry pathogenic microorganisms in their gastrointestinal tract and/or on their hide and fleece without any signs of disease ante-mortem or visible lesions post-mortem.

Hazard identification by many reviewers has shown that in the case of slaughtered animals, food-borne risks to human health are almost entirely due to asymptomatic carriage of enteric pathogens. During slaughter and dressing procedures, these pathogens can be directly or indirectly transferred onto the meat surface. Reducing contamination of the carcass and viscera during dressing and subsequent handling to the lowest level practicable is now recognized as an essential meat hygiene activity.

The post mortem procedures for adult sheep have not been reviewed for many decades since their introduction to New Zealand early last century, with the exception of the head and tongue inspection procedures. The carcass and viscera post mortem procedures at the time of introduction were derived from those in use in the UK and were from an era when the main emphasis of organoleptic post mortem inspection was directed towards the detection of visually and physically obvious diseases and defects. International trade in sheep meat from New Zealand was restricted to frozen product and almost no consideration was given to the role that meat inspection might play in the dissemination of food-borne zoonoses.

In New Zealand the examination procedures for the carcasses and viscera of adult sheep have traditionally involved a high level of palpation. Amongst other major sheepmeat trading countries, the required level of palpation of the carcass is now either much reduced or removed. The US requires palpation of the back and sides of carcasses but not of the abdominal or thoracic cavities, while Canada requires a visual examination of the carcass with a routine palpation of only the superficial carcass lymph nodes. It is noteworthy that the EU has never required routine palpation of the carcass of sheep while Australia only requires palpation of some carcass lymph nodes but with the option of excision and

discarding superficial carcass lymph nodes without inspection. Scientific evaluation of this considerable degree of palpation in New Zealand was a primary objective of this report.

The first major study of ovine post mortem inspection procedures in New Zealand was carried out in 1986. This involved the evaluation of head inspection procedures only and involved 320 000 lambs and 8000 adult sheep. Following a detailed equivalence submission, all our major trading partners agreed with the scientific finding that removal of heads and tongues prior to post mortem meat inspection did not affect judgments of safety or suitability of the carcass or viscera.

The second major scientific evaluation of ovine post mortem inspection procedures was completed in 1991. This involved three years of field trials and primarily focused on lambs. The findings of that study resulted in several routine post mortem inspection procedures for viscera (involving palpation and incision) being removed from the New Zealand standard. Again, following a detailed equivalence submission, the modified post mortem inspection package for lambs was accepted by all our major trading partners.

Recent evaluation of post mortem carcass examination procedures for lambs slaughtered in New Zealand have led to an option to remove almost all palpation of the carcass, provided the carcass is presented to the meat inspector in a manner that facilitates viewing. New Zealand requested recognition of equivalence for these changes from the USDA FSIS and approval for this alternative inspection method for lambs was received in August 2006. These new procedures removed the requirement to palpate the external surfaces of the carcass, superficial carcass lymph nodes, joints, the thoracic cavity and the entire abdominal cavity.

1.2 Current ovine post mortem examination procedures

The divergence of the post mortem examination procedures required by New Zealand for adult sheep from those in our significant sheep meat trading partners can be seen in the following tables.

Table 3: Tissues where New Zealand has significantly different examination procedures compared with the Quadrilateral Group countries and the EU

Tissue	AUS	US	CAN	EU	NZ
Abdominal cavity	V	V	V	V	VP
Bile duct (e)	IV	V	I	IV	VP
Bile duct (i)	IV	V	I	IV	VP
Bronchial Inn	P	P	none	P	VP
Diaphragm	V	V	V	V	VP
Joints	V	V	V	V	VP
Mesenteric Inn	V	V	P	V	VP
Oesophagus	V	V	V	V	VP
Pericardium	none	none	none	V	VP
Pizzle (e)	V	none	none	V	VP
Spleen (e)	P	V on c/c	V	V	VP
Spleen (i)	P	V on c/c	V	V	VP
Testicles (e)	V	none	none	V	VP
Thoracic cavity	V	V	V	V	VP
Tongue (e)	V	V	V	V	VP

Table 4: Tissues where New Zealand's examination procedures for adult sheep are required in only one other Quadrilateral Group country and the EU

Tissue	AUS	US	CAN	EU	NZ
Back of carcass	V	VP	V	V	VP
Heart (e)	P	VP	P	V	VP
Heart (i)	P	VP	P	V	VP
Hepatic Inn	V	none	I	VP	VP
Ischiatic Inn	P	none	none	none	P
Kidneys (e)	V	VP on c/c	V	V	VP
Kidneys (i)	V	VP on c/c	V	V	VP
Trachea (i)	none	none	none	V	V

The post mortem examination procedures for adult sheep in New Zealand not only differ significantly from those required for adult sheep in other countries, but also from those required for lambs in this country. Risk-based post mortem examination requires scientific justification for these differences.

Some of the disparity between the post mortem procedures used between the two ovine classes stems from the evaluation of post mortem meat inspection procedures for sheep carried out in the late 1980s by Hathaway and McKenzie (1990), when a number of recommendations were made regarding the post mortem inspection of lambs only. Following this work, changes to the New Zealand post mortem examination procedures for lamb viscera were introduced for the following tissues: kidneys, liver, bile ducts and hepatic lymph nodes, lungs, bronchial and mediastinal lymph nodes, oesophagus and spleen.

The recommendations by Hathaway and McKenzie (1990) were either for palpation to be discontinued where it served no public health purpose (for the kidneys, hepatic lymph nodes, lungs and spleen) or for the tissue not to be examined routinely (bronchial, mediastinal and mesenteric lymph nodes, and oesophagus) as there was no value in terms of disposition of the carcass.

The guidelines for inspection staff in New Zealand slaughterhouses are currently contained described in Meat Manual 16 The salient differences between the post mortem examination procedures for adult sheep and those for lambs are as follows:

- a. The following tissues are required to be palpated and viewed in adult sheep but only viewed in lambs:
 - Bile duct (inedible)
 - Heart (inedible)
 - Hepatic lymph nodes
 - Kidneys (edible)
 - Kidneys (inedible)
 - Liver (inedible)
 - Lungs (inedible)
 - Pericardium
 - Spleen (edible)
 - Testes (edible)
- b. The following tissues are required to be palpated and viewed in adult sheep but only palpated in lambs:
 - Bronchial lymph nodes (edible)
- c. The following tissues are required to be palpated and viewed in adult sheep but not examined in lambs:
 - Mesenteric lymph nodes

- Oesophagus[†]
- Spleen (inedible)

The following tissues are required to be palpated in adult sheep but not examined in lambs:

- Bronchial lymph nodes (inedible)

d. The following tissues are required to be viewed in adult sheep but not specifically in lambs:

- Abomasum
- Omasum
- Omental fat
- Pancreas
- Peritoneum (visceral)
- Reticulum
- Rumen

As can be seen from the above, there is significantly more palpation required for the post mortem examination of adult sheep than for lambs.

1.3 Potential public health implications

Hazard identification has recently shown that in the case of slaughtered animals, food-borne risks to human health are almost entirely due to asymptomatic carriage of enteric pathogens such as *Salmonella* spp., *Campylobacter* spp. and *Escherichia coli* O157:H7. In contrast, hazard identification reveals that food-borne hazards associated with specific abnormalities identifiable at post mortem inspection are rare.

In the case of adult sheep, it is possible that pathogens such as *Listeria* spp., *Yersinia* spp., *Staphylococcus* spp. and *Streptococcus* spp. may be transmitted to man via meat and the need to take a precautionary approach underlies disposition judgments requiring that all animals showing signs of generalized disease be condemned. However, such pathogens are usually not associated with specific gross abnormalities identifiable at post mortem inspection. It is noteworthy that *Mycobacterium bovis* is

[†] New Zealand is alone in describing the specific sections of the gastro – intestinal tract in the post mortem examination procedures for adult sheep.

extremely rare in sheep in New Zealand having not been reported in this species since 1979, and the cysts of *Toxoplasma gondii*, a pathogen that has been shown to be associated with consumption of undercooked red meat, are not detectable by post mortem inspection.

Globally, modern concepts of meat inspection have advanced from the traditional position where all contamination were detected at one position on the chain and once the carcass had passed inspection, no further examination was necessary. Now, the trend is for the processor to minimise contamination of the carcass by identifying and removing any visible contamination at those steps of the processing chain where this action can be most effectively carried out. This reduces the emphasis on post mortem examination by official inspectors as the sole control point, as has been the traditional practice.

The modern role of the official meat inspector is to facilitate processor actions in the detection and removal of abnormalities from the carcass and viscera. In principle, the identification and removal of abnormalities should not be restricted to one step in the processing chain. For carcasses, routine removal of lymph nodes such as the supramammary, superficial inguinal and precrucial lymph nodes prior to the carcass leaving the slaughterfloor is one expression of this change in approach.

2 Background to this report

2.1 Sheep production in New Zealand

The current New Zealand sheep flock is estimated to be around 32.20 million animals (Beef & Lamb New Zealand - Economic Service – June 2010) and has been reducing in recent years. The flock is currently the lowest recorded since 1955 with the number of breeding ewes estimated to be 22.04 million.

The average annual adult sheep kill for the five calendar years from 2002 to 2006 was approximately 4.3 million although recent adverse climatic conditions and increased number of conversions to dairy farming has resulted in an adult sheep kill of over 5.2 million animals in 2007 and over 6.7 million in 2008. The sheep kill for 2009 was 40% less than for 2008 as the rate of dairy conversion slowed and higher sheep returns encouraged rebuilding of sheep flocks.

Table 5: Slaughter returns for adult sheep from AsureQuality data (2002 to 2010)

Calendar Year	Number slaughtered
2002	4,502,270
2003	4,342,510
2004	4,383,284
2005	4,175,960
2006	4,275,053
2007	5,290,501
2008	6,763,842
2009	4,064,361
2010 to 08 Sept	2,438,389

The class of adult sheep slaughtered in New Zealand includes mostly ewes culled for old age, condition or infertility, along with a small number of adult wethers that have been farmed for fine wool, generally in the South Island. Few adult rams are slaughtered for human consumption.

2.2 Post mortem examination results

When the findings at post mortem inspection of sheep slaughtered in New Zealand are compared with those of other classes and species, there are some significant differences in relation to the relative proportion of the prevalence of pathology, defects and contamination.

Table 6: Prevalence of pathology, defects and total contamination detected at post-mortem examination in sheep, lambs, cattle and young calves (AsureQuality data: 2002 to 2006)

Class of stock	Condition	% of conditions detected
Sheep	Pathology	73
	Defects	9
	Contamination	18
Lamb	Pathology	57
	Defects	7
	Contamination	36
Cattle	Pathology	48
	Defects	27
	Contamination	25
Young Calves	Pathology	13
	Defects	16
	Contamination	71

The disease and defect returns by meat inspection staff indicate that the most common diseases affecting carcasses in adult sheep slaughtered in New Zealand are pleurisy/pneumonia, caseous lymphadenitis, other causes and sarcocyst infection. Of the “other causes” conditions, peritonitis and grass seed are those most frequently encountered by meat inspectors.

Table 7: Adult sheep Disease & Defect Data from AsureQuality Database (01/11/01 to 08/09/10)

Condition	Carcasses detained (%)	Detained carcasses condemned (%)	Slaughtered carcasses condemned (%)
Disease			
Arthritis	1.42	1.80	0.026
CLA *	5.25	1.43	0.075
C. ovis	2.00	0.82	0.016
Facial Eczema	0.011	35.7	0.0039
Neoplasm	0.58	89.1	0.52
Other causes	5.04	1.51	0.076
Pleurisy	25.1	0.084	0.021
Pyogenic lesions	1.77	8.58	0.15
Sarcocysts	4.06	2.87	0.12
Septicaemia	0.025	87.3	0.022
Total Disease	45.26		1.03
Defect			
Emaciation	0.23	95.5	0.22
I.S.L *	5.87	0.014	0.00082
Wounds & Bruises	2.65	0.026	0.0070
Total Defects *	8.75		0.23
Contamination *			
Faecal & Ingesta *	5.64	1.60	0.090
Other *	4.26	0.19	0.008
Total contam. *	9.90		0.098

* denotes data from Jan 2006 to Sept 2010 inclusive. Prior to 2006, most ISLs were recorded as one of “Other Causes” rather than a separate category.

“Other causes” in adult sheep includes: melanosis, icterus, muscle disease (such as lipofuscinosis, eosinophilic myositis and white muscle disease), grass seed, scar tissue, oedema, peritonitis, deformity and gangrene without systemic changes.

Compared to other species and classes of stock, adult sheep have the highest carcass detain rate which is a reflection of the prevalence of pathological conditions in that group of animals.

Wounds and bruises, injection site lesions and emaciation are significant types of defects found in adult sheep.

Table 8: Prevalence of faecal and other contamination in bovine and ovine animals slaughtered in New Zealand from Nov 2001 to Dec 2007 (ASUREQuality data base)

Class of animal	Faecal contamination (%)	Other contamination (%)	Total detained for contamination (%)
Adult Sheep *	5.64	4.26	9.90
Lambs	4.57	2.92	7.49
Adult Cattle	3.88	2.02	5.9
Young Calves	8.5	5.6	14.1

* data from Jan 2006 to Sept 2010 inclusive

The total contamination rate for adult sheep is considerably greater (32%) than that for lambs with the rate for faecal contamination being 23% higher. This may be in part be related to the size of the carcass compared to lambs, difficulty in pelt removal as well as the unfamiliarity of workers who usually process lambs. Many of the larger establishments slaughter ewes on the night shift only and the difference in skill level between the two shifts may contribute to the disparity. It is noteworthy that the sole sheep-only slaughter establishment in New Zealand has had an average faecal contamination rate over the same period of 3.83% (i.e. less than the national average for lambs) which may be a reflection of the single class of stock and consistency of processing by the slaughtermen at that establishment.

Faecal contamination may be either directly or indirectly from fleece contamination or the gastro-intestinal tract. Contamination by ingesta is recorded as faecal contamination. Other contamination may be any of the following: dirt, dust, grease, grit, milk, urine or wool.

3 Scientific evaluation of post mortem examination procedures

3.1 Head and Tongue

3.1.1 New Zealand examination procedures

The New Zealand examination procedures for the head and tongue allow for both the head and tongue to be discarded without examination when not saved for human consumption. When any part of the head is saved for human consumption, it shall be skinned and presented for examination by viewing while the tongue shall be examined by viewing and palpation.

3.1.2 International examination procedures

The US inspection procedures require the head and tongue to be examined by viewing irrespective of whether the head and/or tongue are saved for human consumption.

Canada, Australia and the EU require the surfaces of the head and tongue to be examined by viewing only if saved for human consumption.

3.1.3 Hazard identification

There are no specific food-borne hazards affecting the head and tongue

3.1.4 Abnormal conditions not associated with hazards

Contagious ecthyma (scabby mouth) is not uncommon in lambs but rarely observed in adult sheep. The disease is characterised by external lesions (dry scabs and granulomatous proliferations) that are localised with no evidence of a viraemia. Lesions are usually found around the lips and muzzle, and occasionally inside the mouth and on the surface of the tongue of lambs. Although the virus may infect humans, it has not been recorded as a food-borne zoonosis. The disease has no significance with regard to the disposition of the carcass and viscera.

Parasitic lesions such as *Cysticercus ovis* and *Sarcocystis spp* are rarely found in the head and tongue of adult sheep. Neither parasite has any public health significance.

Routine meat inspection data collected over many years demonstrates that neoplasms are expressed at a significantly higher rate in adult sheep than lambs (approximately 0.5% versus 0.01%). However, in adult sheep, they are almost exclusively found in the viscera. No survey work in New Zealand has found a neoplasm of the head that has impacted on judgment of the carcass or viscera

Corynebacterium pseudotuberculosis infections have been very rarely found in the head and tongue of adult sheep in New Zealand.

3.1.5 Risk profile

Abnormalities of the head and tongue of possible public health importance are extremely rare and are detectable by visual examination.

In a survey carried out in New Zealand of over 320,000 ovine heads, there was not one instance where the head would have served as an indicator function of a condition of public health significance that may have occurred in the carcass or viscera (Hathaway and McKenzie, 1990). Irrespective of whether the head is saved for human consumption, routine inspection of the skinned head provides no assistance in reaching a disposition for the tongue, carcass and viscera. If the tongue and head meats are not intended for human consumption, there is no scientific rationale for presentation and examination of the head.

3.1.6 Post mortem examination considerations

The very low prevalence of abnormalities in the tongue and the absence of any significance that they have to public safety, indicates that routine palpation of the tongue does not contribute to the disposition of the carcass by meat inspection staff and is unnecessary.

3.1.7 Recommendation

When the head is saved for human consumption, it should be presented in a manner that permits hygienic removal of the edible tissue¹.

External surfaces of the head should be viewed when tissues are saved for human consumption.

Tongue should be viewed when saved for human consumption

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¹ Where the head and tongue are not saved for human consumption they may be disposed of without post mortem examination

3.2 Carcass

3.2.1 New Zealand examination procedures

The New Zealand adult sheep inspection code requires that the back of the carcass and all limb joints be examined by viewing and palpation while the ventral surfaces of the carcass, the front of the hindlegs, the forelegs, the axillae, the brisket and neck are to be examined by viewing only.

The New Zealand adult sheep inspection code requires that the thoracic and abdominal cavities be inspected by palpation and visual examination while the pelvic cavity is to be examined by viewing only.

3.2.2 International examination procedures

Canada, the EU and Australia inspection procedures for the external surfaces of the carcass require examination by viewing only.

The US inspection procedures require the external surfaces of the carcass to be examined by viewing followed by palpation of the back and sides of the carcass.

The US, EU, Canada and Australia inspection procedures for the thoracic, abdominal and pelvic cavities require visual examination only in adult sheep.

3.2.3 Hazard identification

Arthritis

Organisms that have been associated with arthritis in sheep in New Zealand include *Erysipelothrix spp.*, *F. necrophorum*, *A. pyogenes*, *Staphylococcus spp.*, *Streptococcus spp.* and *E. coli*. With acute infectious arthritis, the synovial fluid is usually turbid, purulent and occasionally sanguineous. Fibrinous exudate may be present with bursal thickening. The joint may exhibit gross swelling due to the excessive accumulation of synovial fluid.

Arthritis in sheep associated with *Erysipelothrix rhusiopathiae* was more commonly associated with swim dipping, especially after shearing when pathogens could enter the body via fresh shearing cuts; a practice which has now disappeared from modern farming systems with the advent of pour-on acaricides. The disease often resulted in a bacteraemia followed by fibrinous polyarthritis and chronic periarticular fibrosis. While infecting humans from occupational exposure, the organism has not been reported as a food-borne zoonosis.

Infection by gram-negative pleomorphs such as *Actinobacillus spp.*, *Histophilus ovis* and *Haemophilus spp* have been associated with arthritis in sheep (Kater *et al*, 1962) Despite the possibility of the abovementioned micro-organisms having the potential for transmission via meat, there is no robust evidence that meat constitutes a zoonotic pathway for them.

Arthritis is one of the less common pathological findings in adult sheep with an overall prevalence of 1.42% of the kill in recent years (see Table 7) with a peak prevalence generally occurring in May which has averaged 2.14% (AssureQuality data May 2002 to 2009). This peak in late autumn is most likely a reflection of the culling of aged ewes that occurs at that time of year. Of these affected carcasses, only 2% are condemned for arthritis when they exhibit acute arthritis with evidence of systemic involvement (such as generalised lymph node enlargement), or in association with emaciation, or acute polyarthritis with more than one affected joint in more than one limb. For the other 98% of detained arthritic animals, the infection is likely to have resolved and the affected joint is removed from the carcass. Arthritis detected in lambs in New Zealand slaughterhouses usually peaks in September (the end of the slaughter season as animals approach one year of age) and the recent average is 2.06 % (AssureQuality data September 2002 to 2008). Since this prevalence is similar to the rate detected in adult sheep, it is possible that many instances of arthritis observed in adult sheep are resolved conditions gained as a young animal and unlikely to be an active infection when presented for slaughter.

Specific trial work in New Zealand has shown that less than 2% of adult sheep carcasses detained for arthritis have more than one joint affected. For the remainder of the detained carcasses, almost 40% of the affected joints had no indication of gross pathology after incision and examination, but did have abnormal bone growth that reflected chronic lameness rather than infection.

Abscesses

In adult sheep, almost all abscesses in carcass wounds and lymph nodes are likely to be associated with infection by *Corynebacterium pseudotuberculosis*. In most cases the infection spreads to the regional efferent lymph node and produces an abscess in that node. Occasionally the organism may be disseminated from the regional lymph node to affect other lymph nodes and organs. It has been reported as the cause of abscesses in the liver, kidneys, spleen, brain, spinal cord, vertebral bodies, eyes, diaphragm, muscles, heart, tongue, mammary gland, testes, bones and joints (Coetzer and Tustin, 2004). Another cause of pyogenic lesions in sheep is *C. pyogenes*. Neither of the above organisms are regarded as a meat-borne zoonosis (Acha and Szyfres, 1987).

Other organisms that have been associated with pyogenic lesions in sheep include *Streptococcus spp.*, *Staphylococcus spp.*, *Mycobacterium bovis* (Cordes *et al* ,1981), *Fusobacterium necrophorum* although this organism is generally restricted to the feet (West *et al*, 2002). Despite the possibility of the

abovementioned micro-organisms being present in abscesses and being human pathogens, there is no robust evidence that meat constitutes a zoonotic pathway

Bacteraemia/Septicaemia

Systemic infection with *Salmonella spp.*, *Clostridia spp.* (which may also produce a toxæmia) have been reported in adult sheep and the inflammation of the gastrointestinal tract may vary from mild catarrhal enteritis to haemorrhage and ulceration (Jubb and Kennedy, 1972) although animals with the latter pathological changes are unlikely to be presented for slaughter. There may be evidence of fever, hyperaemia, and congestion with associated cloudy swelling in liver, kidneys and heart. Anaemia and jaundice may also be present with blood stained serous exudate in the abdominal and/or thoracic cavity. Other possible signs may include inadequate carcass bleeding, splenomegaly, petechial or ecchymotic haemorrhages in kidney, epicardium, mucous and serous membranes. In longer standing cases there may also be degenerative changes in the liver, heart and kidneys with associated lymphadenopathy.

Infection of the peritoneum (peritonitis) may lead to septicaemia and generally occurs either through rupture of the gastro-intestinal tract, some bacteraemias such as salmonellosis, inflammatory conditions of the uterus in ewes, or as a consequence of abscesses in the liver or kidney. Both acute fibrinous peritonitis and chronic localised peritonitis are conditions commonly seen in adult sheep as a result of extensive fascioliasis.

Imperfect bleeding sometimes appears similar to septicaemia or toxæmia. This condition is usually related to the parameters of electrical stunning or a poor thoracic stick technique. The condition is usually discernable by engorged intercostal veins and is not considered to be of significance with respect to food safety.

Bacteraemia and septicaemia must be regarded as conditions of potential public health importance

Contamination

This involves direct and/or indirect contact between the carcass of the adult sheep and faecal matter, ingesta, milk and urine. Where sheep have been washed prior to slaughter in a swim wash, there is a likely increase in microbial contamination of the fleece by enteric organisms that have accumulated in the water from preceding animals. Microbial contamination of carcasses will range in description from the grossly visible to the non observable but all contamination has the potential to affect the hygienic status of the carcass. As previously stated, micro-organisms of enteric origin are the most important hazard to human health.

Micro-organisms that may contact carcass surface during the processing of adult sheep include the following: faecal coliforms such as shigatoxin-producing *E.coli* (STEC), *Clostridial* spp., *Campylobacter* spp., *Salmonella* spp. including *S.brandenburg*, *Staphylococcus* spp., *Streptococcus* spp., *Listeria monocytogenes*, *Yersinia* spp., Noroviruses, *Giardia* spp., *Cryptosporidium parvum* and Coccidia.

Enteric microflora from both the colon and the oesophagus may contact the internal carcass surface during processing. As described above for the possible contamination of the external carcass, the intestinal lumen contents of adult sheep have been reported to contain a range of pathogenic microflora.

Gangrene

This condition is very rarely observed during processing due to a low prevalence of gangrene on the farm and the likelihood of detection during ante-mortem inspection. Gangrenous tissue is often soft, swollen, dark or greenish in colour and malodorous. The condition is readily detected by visual and olfactory examination.

Injection Site Lesions

Subcutaneous injections are given to lambs and sheep throughout their lifetime in most farming operations in New Zealand. While some of these compounds involved may be classified as a hazard to human health, the imposition of withholding times and other precautions mitigates against any risk to human health. Nevertheless, ISLs are presented as hazards in this report as a precaution.

These may include any of the following:

1. Anthelmintics including: abamectin, clorsulon, doramectin, ivermectin and moxidectin.

The above anthelmintics have withholding times (WHT) from between 28 to 35 days, and 91 days for long acting dosages or if any animals should be inadvertently injected intramuscularly (IVS Annual, 2010). Some injections may be an anthelmintic, vaccine and mineral in one combination.

2. Mineral supplements including:

- Copper as copper glycinate, copper disodium EDTA, cupric glycinate or calcium copper edentate
- Iodine organically bound to ethyl esters of unsaturated fatty acids (mainly oleic and linoleic) in peanut oil
- Iron dextran
- Manganese as disodium manganese EDTA

- Selenium as sodium selenate, sodium selenite or barium selenate
- Zinc as disodium zinc EDTA

All of these mineral preparations have a nil WHT.

3. Ovulation boosters including: androstenedione protein complex and polyandroalbumin

Both of these products have a nil WHT.

4. Vaccinations

These preparations are used in sheep to provide protection against the following: *Campylobacter* spp., *Clostridium* spp., *Corynebacterium pseudotuberculosis*, *Dichelobacter nodosus*, *Erysipelothrix rhusiopathiae*, *Leptospira* spp., *Mannheimia haemolytica*, *Mycobacterium avium* subsp. *paratuberculosis*, *Pasteurella trehalosi*, *Salmonella* spp. and *Toxoplasma gondii*.

All of these vaccines have a nil WHT (unless given in combination with an anthelmintic when the WHT may be up to 49 days) and some of these preparations may include mineral supplements such as sodium selenate or vitamin supplements such as hydroxocobalamin.

5. Vitamins: all vitamin injections have a nil withholding time and include: Vitamin A (as propionate), Vitamin B1 (as thiamine HCl), Vitamin B2, Vitamin B6, Vitamin B12 (cyanocobalamin and/or hydroxocobalamin), Vitamin B15, Vitamin D3 (as cholecalciferol) and Vitamin E (as di-alpha tocopherol acetate)

Some sustained release vitamin implants are recommended by the manufacturer to be administered just behind the base of the ear which may be the anterior neck in practice for some animals.

The manufacturer's recommendation for these products is for the dose to be given subcutaneously in the anterior half of the neck. Farmers are advised to sterilise all injection apparatus before use and to change needles often and as necessary. However any subcutaneous injection carries the risk of introducing pathogens from the environment into the animal and undoubtedly some injection sites become infected, especially if the practice is carried out while the fleece is wet and/or contaminated. The manufacturers of some injectable products (e.g. barium selenate) advise that a small nodule may occur at the injection site which will disappear within a month.

There has been a suggestion that intramuscular and/or subcutaneous tissue reactions may have the potential to cause slow or erratic depletion of veterinary medicines and/or their metabolites compared to ordinary tissue away from the injection site (Hathaway, 1996). New Zealand does not routinely sample and test ISLs and uses a line-by-line approach to restrict analysis to those lesions where other information suggests that sampling is warranted. This information may include the number of affected

animals in the line, the site of the ISL, the animal species and age and, if necessary, information from the supplier as to the injectable compound(s) used.

The recorded prevalence of ISLs that has been detected in adult sheep by meat inspectors has increased in recent years, which is a reflection of the increased use of injectable animal health products over the last decade as well as a transition in 2006 to recording the defect from being included within Other Causes to a specific ISL category.

Table 9: Prevalence of injection site lesions in adult sheep in New Zealand from 2003 to 2009 (AsureQuality data base)

Year	Prevalence %
2003	0.15
2004	0.10
2005	0.56
2006	6.29
2007	6.81
2008	5.60
2009	5.49

Most ISLs are located in the neck of adult sheep and in one NZFSA survey carried out in 2007, the distribution of lesions around the carcass was found to be: neck (92%), back (7.3%), rump (0.6%) and flank (0.08%).

The same survey indicated that approximately 80% of lesions required palpation for their detection.

3.2.4 Abnormal conditions not associated with hazards

Caseous lymphadenitis (CLA) is one of the more commonly detected conditions in adult sheep slaughtered in New Zealand with an average prevalence of 5.25% over the preceding five years (AsureQuality database, 2004 to 2009).

The infection by *C.pseudotuberculosis* is restricted to a single lymph node in the carcass in almost all cases of CLA in adult sheep with less than 0.5% of carcasses detained for CLA in an NZFSA trial carried out in 2007 on over 12,300 ewes having two or more lymph nodes affected. This demonstrates the lack of scientific support for any indicator function of specific sites. The most common sites of infection in adult sheep in New Zealand are the subiliac and superficial cervical lymph nodes which account for approximately three quarters of all CLA lesions detected. The condemnation rate for those carcasses detained for CLA is around 1.4% and this includes those carcasses that either display evidence of systemic involvement, are of poor condition with acute lesions or have four or more extensive lesions including those detected in the viscera which may be either chronic or acute lesions

Infection with the Maedi-visna virus may produce arthritis in sheep, usually in the carpal and tarsal joints. The virus however has not been reported in New Zealand. Similarly, infection with the caprine arthritis encephalitis (CAE) virus has been known to cause clinical arthritis in sheep but has not been reported in New Zealand. Neither of the two above viruses are zoonoses

Grass seeds are occasionally seen in adult sheep in New Zealand and is usually due to infiltration of the pelt by the seed of Barley grass (*Hordeum murinum*). This grass does not set its seed until late summer and is usually readily apparent in an affected line of sheep. The seed will penetrate the skin of an animal and is usually observed under the superficial fascia of the carcass. The seed often produces no local reaction under the pelt and in itself does not pose a risk to food safety. A less frequent grass seed seen in adult sheep carcasses comes from the Hook grass (*Uncinia uncinata*) which occasionally may be seen in high country sheep in the South Island. Other species of grass seed are occasionally found in adult sheep.

All such affected carcasses are detained for trimming. There is provision for lines of badly affected sheep carcasses to be transferred to an auxiliary rail for trimming after which final post mortem inspection is provided.

Icterus is occasionally observed in the adult sheep carcass and involves the presence of bilirubin and biliverdin in vascular circulation. The reabsorption of bile pigment into the circulatory system may occur from obstruction to the flow of bile or from severe cirrhosis.

Hepatic toxicity by ingestion of the spores of *Pithomyces chartarum* (clinically known as facial eczema) may result in icterus and this is usually seen in the acute stage in late summer and autumn. Ingested sporodesmin concentrates in the bile causing pericholangitis. Prolonged ingestion of ragwort (*Senecio jacobea*) by sheep will also produce icterus.

Most adult sheep in which facial eczema is detected have gross pathology limited to the liver. Since 2001, the prevalence of facial eczema in adult sheep has remained very low at 0.011% with more than a third of these carcasses (35.7%) being condemned for icterus (see table 7).

Melanosis represents abnormal deposits of melanin and in the sheep is found most commonly in the liver, both on the surface and in the parenchyma of the organ (Thornton, 1965). It may also be observed in the intima of large blood vessels, particularly at the root of the aorta, and in the uterus and oviducts of the ewe. The condition may be seen adjacent to the sacrum and vertebral column, and under pleura overlying ribs and intercostal muscle.

Neoplasms are rarely encountered in the carcass of adult sheep. The most common type seen in New Zealand is lymphosarcoma which is characterised by enlargement of most or all carcass lymph nodes. More rarely, other neoplasms have been reported overseas in adult sheep such as a rhabdomyosarcoma in skeletal muscle adjacent to the tibia (Yener, 2001) and a lymphoma affecting the synovial in both tarsal

joints of an aged sheep (Pearson *et al*, 1999). Neuromata of the intercostal nerves have occasionally been reported and are visible as small thickenings beneath the parietal pleura (Thornton, 1962). Neoplasms have no known public health significance but their removal is considered important for consumer acceptability.

The parasites *Cysticercus ovis*, *C. tenuicollis* and *Sarcocystis* spp. all are found in adult sheep in New Zealand. *Echinococcus granulosus*, which is of considerable significance to human health, has been eradicated from New Zealand which was declared free of hydatids in 2002.

The sites of predilection in sheep for the intermediate stage of the parasite *Taenia ovis* include the heart, diaphragm and abdominal wall with cysts also being detected less frequently in the thoracic cavity, flank and neck. The cyst undergoes calcification and eventual degeneration in the live animal and the period between infection and the onset of calcification is up to 90 days generally. From November 2001 to September 2010, the average prevalence of *C. ovis* detected by meat inspection staff in adult sheep was 2.0 % with only 0.82% of these detained carcasses having sufficient numbers of cysts throughout the musculature to warrant condemnation.

C. tenuicollis is rarely encountered in adult sheep by meat inspectors with one trial carried out on over 6500 lambs revealing only one *C. tenuicollis* and 138 *C. ovis*. The cyst is characterised by a long necked fluid filled sac that is usually attached to the abdominal wall, omentum, mesentery or organs especially the liver. It is always subserous and never intramuscular. Almost all adult sheep carcasses in which this parasite is identified exhibit a single cyst only.

Infestation with *Sarcocystis tenella* may occur in the striated and heart muscle of sheep. The sites of predilection in adult sheep include the internal abdominal wall, the intercostal musculature and oesophagus with the spindle shaped cysts up to 15 mm in length easily observed. Affected carcasses are detained and trimmed. Very few carcasses are so extensively infested that condemnation is warranted.

Pleurisy is the most common disease reported from adult sheep in New Zealand with a quarter of all adult sheep carcasses being retained for removal of associated fibrous adhesions. Scientific evaluation indicates that pleural lesions are very unlikely to have any significance in terms of public health

Enzootic pneumonia is a common disease of sheep in New Zealand, especially of hoggets and is generally agreed to occur in one of two clinical and pathological forms; acute fibrinous pneumonia in sheep of all ages and chronic non-progressive pneumonia which occurs in younger sheep (West *et al*, 2002) The inter-relationship between the two diseases is uncertain and it is believed by some that the chronic and subacute lesions may arise from the progression of mild forms of acute pneumonia which develop into a residual form of the disease or alternatively it may be that the acute pneumonia (of the "Pasteurella-type") develops from pre-existing chronic non-progressive pneumonia in circumstances when the sheep is stressed or when super-infection occurs with more virulent strains of organisms. In

cases of chronic non-progressive pneumonia, colonisation of the lungs with mixed strains of *Mycoplasma ovipneumoniae* may result in ciliostasis and thereby allowing colonisation of the lungs with other pathogens. *Bordetella parapertussis* may also play a role in initiating or prolonging chronic non-progressive pneumonia. Microorganisms that are believed to be involved in the pathogenesis of enzootic pneumonia in sheep include *Pasteurella (Mannheimia) haemolytica*, *P. haemolytica* type T, *P. multocida*, *Bordetella parapertussis*, *Mycoplasma ovipneumoniae* and *M. arganini*, Parainfluenza virus type 3, Respiratory syncytial virus, Ovine adenovirus type 6 and Bovine adenovirus type 7 (West *et al*, 2002)

The nature of the pneumonic lesions is determined by the degree of bacterial proliferation and usually the infection is confined to the lung and thoracic cavity where permanent fibrous scars may be left. As for pleurisy, scientific evaluation indicates that pneumonic lesions of sheep are very unlikely to have any significance in terms of public health.

Scar tissue is usually the result of cuts and lacerations received during shearing in adult sheep and do not present a risk to the consumer.

White muscle disease historically was a condition seen in lambs that were raised in selenium deficient areas but now is rarely seen in adult sheep or lambs in New Zealand since the widespread use of selenium enhanced anthelmintics has largely prevented its occurrence (West *et al*, 2002). The condition has no public health significance.

Wounds and bruises are not uncommon in the carcasses of adult sheep and this may be a reflection of the increased handling that may occur prior to slaughter for some animals. This includes drafting and trucking from farms, passage through the sale yards for some, and handling through the lairages and washes at the processing premises. Wounds are far less common in adult sheep and are usually incurred through being shorn. The average prevalence of wounds and bruises in adult sheep recorded by meat inspectors from 2001 to 2010 is 2.65% (AssureQuality data base).

Xanthosis is characterised by a brown colouration of the muscles and always associated with adrenal gland pathology. The condition is readily apparent visually.

3.2.5 Risk Profile

Hazards that do pose a potential threat to the consumer include enteric organisms such as STEC, *Campylobacter spp*, *Salmonella spp.*, *Cryptosporidium parvum* and systemic organisms including *Listeria monocytogenes*, *Clostridial spp* and *Toxoplasma gondii*. Apart from those carcasses that exhibit signs of systemic infection such as septicaemia due to *Salmonella*, infection by any of the above will not be detected by organoleptic examination.

The vast majority of abnormalities that are routinely detected in the carcasses of adult sheep by post mortem examination have no relevance to the health of the consumer. These include caseous lymphadenitis, resolved arthritic joints, contamination by grit and small clumps of wool, grass seed, icterus, injection site lesions, melanosis, white muscle disease, parasites, resolved pleurisy, scar tissue, wounds and bruises and xanthosis.

Although there may be occasional involvement of zoonotic pathogens in pleural lesions and pneumonia, scientific evaluation indicates that such lesions are very unlikely to have any significance as a source of food-borne illness

3.2.6 Post mortem examination consideration

Current inspector positioning allows for communication between carcass and viscera inspectors in the eventuality of a carcass disposition being supplemented by additional information being available from the viscera inspector.

Presentation requirements for examination of the carcass obviously impact the effectiveness of some procedures. The scientific evaluations that have been carried out in this study are in the context of the following presentation requirements:

- removal of the tail, pizzle and fat curtain sufficient to enable adequate visual examination of the pelvic cavity
- abdominal wall being incised in a manner that adequately exposes the pelvic cavity.
- the brisket is required to be split

In order to reduce the likelihood of potential contamination of the carcass by meat inspectors, there should be a credible justification for the requirement of any palpation of the carcass. The procedures should continue to provide an appropriate level of performance for detection and removal of abnormalities of food safety and suitability importance. The most frequent conditions detected in adult sheep at post mortem examination in New Zealand include CLA, contamination, *C.ovis*, injection site lesions, pneumonia/pleurisy and sarcocysts. Of the other pathological conditions found in sheep, such as arthritis, peritonitis, septicaemia and wounds and bruises, there are none that are restricted to deep tissue in the carcass and it is evident that none of these conditions require palpation to assist in their detection.

Palpation of the external carcass lymph nodes is primarily to detect CLA in adult sheep and New Zealand trial data indicates that almost (over 98%) all affected carcasses have only one lymph node affected. The condition is of no consequence to human health but should be removed from the carcass where detection is commensurate with hygienic processing and to meet appropriate suitability requirements. The superficial inguinal, supramammary and subiliac lymph nodes are more easily assessed as to the

presence of an abscess being superficial. The two former, and frequently the latter, lymph nodes are routinely removed prior to the carcass leaving the slaughter floor, which removes the need to examine these nodes.

The popliteal lymph node is situated midway between the surface of the hind leg and the femur and despite this lymph node being affected in less than 8% of adult sheep carcasses detained for CLA, the importance of suitability for this high value portion of the carcass necessitates examination by palpation. However, palpation is relatively insensitive. It is estimated from NZFSA studies that approximately 7 carcasses per thousand have CLA lesions in a popliteal lymph node and approximately 3 of these are missed with current routine post mortem examination by visual inspection and palpation. If palpation is not carried out, the non-detection rate per 1000 carcasses increases from 3 to 6.

The superficial cervical lymph node is affected in approximately 40% of carcasses detained for CLA and although for some shoulder cuts the lymph node is trimmed from the cut, for the square cut shoulder the lymph node is included. As for the popliteal node, detection is enhanced by palpation. It is estimated from pilot studies in New Zealand that approximately 35 carcasses per thousand have CLA lesions in the superficial cervical nodes and approximately 14 of these are missed during current routine post mortem examination which includes visual inspection and palpation. If palpation is not carried out, approximately 28 affected carcasses per thousand are likely to be missed.

Routine removal of specified superficial lymph nodes prior to post mortem examination provides an alternative to presentation and routine examination of these lymph nodes.

In recent surveys regarding the relative merit of palpation and viewing versus viewing only for *C. ovis* cysts in the abdominal cavity, viewing alone detected 33% of the total number of cysts detected in the abdominal cavity by both viewing and palpation at a high chain speed establishment., At a slow chain speed establishment, a very different picture emerged with palpation only adding another 3% of detections to those seen by viewing alone.

Injection site lesions (ISLs) have become more common in adult sheep as the use of injectable animal health products has become more widespread by sheep farmers in New Zealand. Although some products (anthelmintics) have a withholding period, most do not and initial trial work appeared to confirm that the non-detection rate for ISLs would decrease significantly if palpation of the neck was required. A survey of two adult sheep slaughtering establishments indicated that the proportion of ISLs that were detected by viewing only ranged from 16% to 47%, with the more sensitive result obtained from the establishment with the slowest chain.

At present the neck is only required to be examined by viewing but in practice almost all meat inspectors palpate the neck specifically to detect ISLs.

The carcass shall be presented in a manner that facilitates the viewing and examination of the thoracic, abdominal and pelvic cavities. This requires the removal of the tail, pizzelle and fat curtain along with abdominal wall being incised in a manner that exposes the pelvic cavity. The brisket shall be split.

Current inspector positioning allows for communication between carcass and viscera inspectors in the eventuality of a carcass disposition being supplemented by additional information being available from the viscera inspector

3.2.7 Recommendations

Presentation requirements for the carcass should include; removal of the tail, pizzelle and fat curtain sufficient to enable adequate visual examination of the pelvic cavity, the abdominal wall being incised in a manner that adequately exposes the pelvic cavity and the brisket is required to be split

For public health purposes, external and internal surfaces of the carcass should be viewed and the neck should be palpated for injection site lesions.

For suitability purposes, the popliteal and superficial cervical lymph nodes should be palpated.

For suitability purposes the ventro-lateral abdominal wall should be palpated for the detection of *C. ovis*.

Routine removal of superficial inguinal, supramammary, subiliac and superficial cervical lymph nodes provides an alternative to examination.

3.3 Viscera

3.3.1 Diaphragm

3.3.1.1 New Zealand examination procedures

The New Zealand adult sheep examination procedures require that the diaphragm be inspected by visual examination and palpation.

3.3.1.2 International examination procedures

Canada, the US and Australia have no examination procedures specific for the diaphragm apart from a general requirement to observe the internal surfaces of the carcass. These countries do not describe any procedure to examine the diaphragm as part of the viscera.

The EU inspection procedures require visual inspection of the diaphragm.

3.3.2 Hazard identification

There are no specific hazards affecting the diaphragm.

3.3.3 Abnormal conditions not associated with hazards

In New Zealand the parasite *C. ovis* is found in all carcass musculature, although post mortem surveys have demonstrated that the cyst is most frequently found on the surface of and within the musculature of the heart, diaphragm and abdominal wall. The intermediate stage of *C. tenuicollis* has very occasionally been reported as attached to the diaphragm and is easily observed. Sarcocysts may also be present in the diaphragm although are more commonly observed in the internal abdominal wall, intercostal musculature and oesophagus.

Melanosis may be seen adjacent to the sacrum and vertebral column, and under pleura overlying ribs and intercostal muscle. Xanthosis is very rarely found in the diaphragm. Ochronosis, caused by the deposit of a yellow-brown or chocolate brown pigment in cartilage, tendon sheaths and joints, may also be rarely seen.

3.3.4 Risk profile

There are no foodborne hazards specific to the diaphragm.

3.3.5 Post mortem examination considerations

Current dressing procedures at most ovine processing establishments include the removal of most of the diaphragm from the carcass during evisceration and placement on the viscera table. This practice is recommended for all processors as providing the least risk to the carcass by removing the need to examine the diaphragm within the abdominal cavity and so increasing the likelihood of contaminating the carcass unnecessarily. Pleurisy is almost never restricted to adhesions involving only the diaphragm and so may be detected by viewing the surface of the thoracic cavity as well as the parenchyma of the lung set.

NZFSA surveys have indicated that *C. ovis* is detected mainly in the abdominal wall and diaphragm with less than a quarter of all detected cysts being discovered in other tissues or areas such the thoracic cavity, neck, flank and oesophagus. A recent NZFSA pilot trial of the effectiveness of post mortem examination of adult sheep, by viewing and palpation versus viewing only, showed that viewing alone was

less effective than viewing and palpation in the detection of *C.ovis* cysts, although this difference was associated with chain speed.

At an establishment with a low chain speed where the diaphragm was left in the carcass, over 90% of the detected cysts were discovered by viewing rather than viewing and palpation, while at the high speed chain only half of the cysts were detected by viewing.

3.3.6 Recommendation

As much as practical of the diaphragm should be removed from the carcass and examined on the viscera table.

For public health purposes the diaphragm should be viewed.

For suitability purposes the diaphragm should be palpated.

3.4 Gastro-intestinal tract including mesenteric lymph nodes

3.4.1 New Zealand examination procedures

The New Zealand adult sheep examination procedures require that the oesophagus be examined by viewing and palpation, while the rumen, reticulum, omasum, abomasum, omental fat and intestines are to be examined by viewing. There is no specific requirement to examine the mesentery but a representative proportion of the mesenteric lymph nodes are to be viewed and palpated.

3.4.2 International examination procedures

Australia, Canada, the EU and the US examination procedures require that the gastro-intestinal tract be examined by viewing without specifying the procedure for each division of the stomach. The US, the EU and Australian adult sheep examination procedures require the mesenteric lymph nodes to be examined by viewing, while Canada requires that the mesenteric nodes be examined by viewing and palpation.

3.4.3 Hazard identification

Abscesses

Infections by *Mycobacterium avium* subsp. *paratuberculosis* known as Johne's disease have been reported in adult sheep in New Zealand since 1952. The organism is taken up by macrophages in the

epithelial dome overlying Peyer's patches in the small intestine which lead to small granulomatous lesions in the ileum. Eventually the chronic granulomatous enteritis involves the mesenteric lymph nodes which become enlarged, diffusely pale and occasionally necrotic and mineralized (West *et al*, 2002). While there are references in the literature to association of consumption of meat with zoonotic transmission of Johne's disease, there is no robust epidemiological evidence to support this reported association.

Chronic granulomatous conditions found in the mesenteric lymph nodes of adult sheep have included infection by *Mycobacterium bovis* although this organism has not been detected in sheep in New Zealand since 1979.

Enteritis

There are several causes of enteritis in adult sheep and almost all animals suffering from enteritis will not be presented for slaughter due to the acute and obvious symptoms. For those cases that do reach post-mortem inspection the intestines will usually be hyperaemic with petechial haemorrhages. The primary reservoir of many *Salmonella* spp. is the vertebrate intestine and in clinical cases, inflammation of the gastro-intestinal tract can vary from mild catarrhal enteritis to haemorrhage and ulceration (Jubb and Kennedy, 1972). Infection by *Salmonella* spp. is primarily a disease of adult sheep rather than lambs (West *et al*, 2002) and may result in generalised hyperaemia and congestion of the viscera which will be readily apparent on the surface of the abomasum or lower gastro-intestinal tract and elsewhere in the carcass and viscera (Richards *et al*, 1993). Although the primary reservoir of *Salmonella* spp. is the intestine, infection of adult sheep by *Salmonella* spp. has also been reported as causing enlarged, oedematous or haemorrhagic mesenteric lymph nodes (West *et al*, 2002).

Septicaemia/bacteraemia

Systemic infection with *Salmonella* spp., *Clostridia* spp. (which may also produce a toxemia) occurs in sheep and inflammation of the gastrointestinal tract may vary from mild catarrhal enteritis to haemorrhage and ulceration (Jubb and Kennedy, 1972) although animals with the latter pathological changes are unlikely to be presented for slaughter. Congestion of the intestines due to infection by *C. sordellii* has been reported (West *et al*, 2002) There may be evidence of fever, hyperaemia, and congestion with associated cloudy swelling in liver, kidneys and heart. Anaemia and jaundice may also be present with blood stained serous exudate in the abdominal and/or thoracic cavity. Other possible signs may include inadequate carcase bleeding, splenomegaly, petechial or echymotic haemorrhages in kidney, epicardium, mucous and serous membranes. In longer standing cases there may also be degenerative changes in the liver, heart and kidneys with associated lymphadenopathy.

Infection with some *Clostridium* spp. may produce specific lesions in the abomasal mucous membrane and generally require predisposing nutritional and environmental causes (Schamber *et al*, 1986). These

include *C. perfringens* types A, B, C and D, all of which may produce enterotoxaemia in sheep and *C. sordelli* which has been implicated as a cause of sudden death of sheep in New Zealand (West *et al*, 2002). Gross pathological findings included various combinations of bloat, haemorrhage and ulcers in the abomasum. (Vatn *et al*, 2000)

Severe abomasitis caused by *Clostridium septicum* characterized by diffuse suppurative inflammation, oedema, and emphysema has been reported in lambs (Eustis and Bergeland, 1981) and is well known as a problem in wintered hoggets in Scotland possibly caused by the ingestion of frozen food. Despite similar predisposing factors in parts of New Zealand, particularly in Southland, it has not been reported in sheep (West *et al*, 2002). *C. sordellii* has been implicated as a cause of sudden death of sheep in New Zealand while overseas abomasitis has been reported from sheep of all ages affected by *C. fallax*, *C. sordellii* and *C. perfringens* with gross pathology including congestion, oedema and haemorrhage of the abomasal mucosa (Vatn *et al*, 2000) It is still not clear whether *C. sordellii* is an important pathogen, a post mortem invader, or an incidental finding (West *et al*, 2002).

In New Zealand, *Listeria* spp. have been reported as causing fatal gastroenteritis in sheep (West *et al*, 2002) with necropsy revealing a suppurative and/or ulcerative abomasitis, enteritis and colitis. *Listeria monocytogenes* has been isolated from the mesenteric lymph nodes of adult sheep that have been experimentally infected per os (Zundel and Bernard, 2006).

3.4.4 Abnormal conditions not associated with hazards

Infection of adult sheep by *Corynebacterium pseudotuberculosis* is usually confined to superficial carcass lymph nodes but occasionally is found in the liver, spleen and mesenteric lymph nodes.

Coccidiosis of sheep is characterised by an abomasal mucosa which grossly thickened with a nodular surface and focal areas of haemorrhage. Although acute coccidiosis is more often seen in lambs less than 4 months of age, the condition may be rarely found in adult sheep. Infection is usually due to a mixed infection of coccidian, although one species may predominate with *Eimeria ovinoidalis* being the most common pathogen in New Zealand (West *et al*, 2002). Microscopically, the middle to deep abomasal mucosa contained many intact and ruptured giant protozoal schizonts associated with hyperplasia of mucous neck cells, parietal cell atrophy, moderate lymphocytic-plasmacytic inflammation, and fibrosis centred on mineralized remnants of degenerate schizont walls. Grossly a severe enteritis including abomasitis is likely to be apparent.

The white fusiform cysts of *Sarcocystis gigantea* (tenella) and more rarely *S. medusiformis* are commonly found in the connective tissue of oesophagus of adult sheep but neither species is transmissible to humans. Occasionally, cysts of *C. ovis* occur in the musculature of the oesophagus and similarly have no relevance to human health.

Some helminths specifically target the abomasum (e.g. *Haemonchus contortus*, *Ostertagia* spp) but apart from some internal mucosal erosion will generally be inapparent upon viewing. Abomasal morphology includes thickening of the fundic mucosa, fewer parietal cells and mucous cell hyperplasia which is prominent within nodules associated with larval development (Scott *et al*, 1998). These parasites have no relevance to public health.

Perforation of the abomasum has been reported in a lamb that contracted Wesselsbron disease along with petechial and echymotic haemorrhages in the mucosa of the abomasum and generalized lymphadenopathy. No other obvious macroscopic lesions were noted while microscopy on the liver showed mild to extensive necrosis of the parenchyma. (Coetzer *et al*, 1978) Haemorrhages were also frequently seen in the mucosa of the abomasum in animals affected by Rift Valley fever (Coetzer, 1977). Both of these diseases are not present in New Zealand.

Carcinomas of the small intestine are occasionally reported in adult sheep in New Zealand. This neoplasm (also known as adenocarcinoma) was considered to be either due to a genetic predisposition or an environmental carcinogen (Simpson, 1972) with the author suggesting that the prevalence of these neoplasms differed according to the breed of sheep with a much lower prevalence in fine-woolled breeds although stocking rate and geographical distribution of the sheep were other factors to be considered. Recent work has suggested that the genetic predisposition is unlikely (Munday *et al*, 2008) and nor are they considered to be associated with infection by herpesviruses, *Helicobacter* species or *Mycobacterium avium* subspecies *paratuberculosis* (Munday *et al*, 2009). These conditions are characterised by a primary annular thickening and stenosis of the ileum with various degrees of permeation along the intestine which is readily apparent by viewing.

Adenocarcinomas have also been reported in the mesenteric lymph nodes of adult sheep and are believed to spread from the ileum via the lymphatics to the mesenteric lymph nodes (Manktelow, 1984). B-cell leukaemia has also rarely been reported in adult sheep with post mortem findings included a diffusely enlarged, dark-red friable liver, mild splenomegaly, and mild mesenteric lymphadenopathy (Valentine and McDonough, 2003)

Neoplasms have not been reported in the oesophagi of adult sheep. Lymphadenopathy is defined as a regional or generalised lymph node enlargement of unknown or unspecified cause (Jubb and Kennedy 1972) and the essential architecture of the lymph node is usually preserved. Known causes of lymphadenopathy include systemic abscessation, endocarditis and lymphoma which also produce pathological changes in the liver, spleen, heart and kidney.

The immature nymphs of the parasite *Linguatula serrata* have been detected in the mesenteric lymph nodes of adult sheep overseas (Miclaus *et al*, 2008) but not in New Zealand.

Grazing by sheep of some toxic plants such as *Brachiaria decumbens* has produced gross lesions that included whitish spots of multifocal distribution surrounded by reddened halos in the mesenteric and hepatic lymph nodes. (Driemeier *et al*, 2002) but has not been recorded as being amongst the poisonous plants of New Zealand (Connor, 1977). .

3.4.5 Risk profile

Bacteraemia, septicaemia and enteric inflammatory conditions are obvious sources of potential food-borne risks and must be catered for in post mortem examination of the gastro-intestinal tract.

Neoplasms of the gastro-intestinal tract are not regarded as being of any public health importance but their detection and removal is an important consumer acceptability issue.

3.4.6 Post mortem examination considerations

The listing of the examination procedures for each division of the adult sheep stomach is unnecessary and if itemised as each requiring individual examination, may lead to unwarranted handling of the viscera by meat inspectors if, for example, the omasum is obscured. Although the position of the viscera on a table or tray may at times prevent some sections of the gastro-intestinal tract being viewed, there are no conditions of significance to public health that are restricted to any one division of the stomach of the adult sheep and examination of each division in every viscera set is unnecessary. Sufficient sections of the gastro-intestinal tract must be presented to the inspector for viewing.

The occurrence of parasitic cysts in the oesophagus of adult sheep in New Zealand is dominated by *Sarcocystis* spp with other sites of predilection including the internal abdominal wall and intercostal musculature.

Abnormalities may occasionally be seen in the intestines and mesentery of adult sheep and are frequently limited to changes seen during a systemic condition such as peritonitis, septicaemia and /or hyperaemia which will be readily apparent elsewhere in the carcass. Occasionally enteritis, such as those caused by *Salmonella* spp. may be restricted to congestion and hyperaemia of the intestines, and where the abnormality is haemorrhagic or gangrenous, all parts of the carcass and viscera must be condemned.

Contact with the intestinal tract and especially the severed end of the colon should be minimised.

3.4.7 Recommendation

The gastro-intestinal tract², including a representative proportion of the mesenteric lymph nodes, should be viewed.

Heart and pericardium

3.4.8 New Zealand examination procedures

The New Zealand adult sheep inspection code requires that both the pericardium and heart be examined by observation and palpation.

3.4.9 International examination procedures

The US has no examination requirement for the pericardium and requires the heart to be examined by palpation and observation.

Australia and Canada have no examination requirements for the pericardium and require the heart to be palpated only.

The EU requires only routine visual inspection of the pericardium and heart, while in the event of doubt the heart must be incised and examined.

3.4.10 Hazard identification

Generalised conditions such as septicaemia and toxæmia often result in gross pathological changes in the heart (Jubb and Kennedy, 1972, Thornton and Gracey, 1974). These include cloudy swelling, fatty degeneration, petechial haemorrhages and blood-stained fluid in the pericardial sac. Although most septicaemic or toxæmic sheep will not be presented for slaughter, possible causes may include *Salmonella* spp. and *Clostridia* spp.

Inflammation of the pericardium and the epicardium frequently occur concurrently, and may extend to the myocardium. Acute pathology includes fibrinous, serofibrinous and suppurative inflammatory changes, and there may be evidence of systemic involvement elsewhere in the carcass and/or viscera (Jubb and Kennedy, 1972). Infection by *Clostridium perfringens* type D has been reported as causing vascular

² The listing of the examination procedures for each division of the adult sheep stomach is unnecessary and if itemised as each requiring individual examination.

endothelial damage to the myocardium (West *et al*, 2002) although the likelihood of such toxæmic animals being presented for slaughter is remote.

Sporadic cases of endocarditis occur in all species while subendocardial haemorrhages may be seen in cases of septicaemia and toxæmia.

3.4.11 Abnormal conditions not associated with hazards

Jaundice is very occasionally observed in the carcass and viscera of sheep and this generalised condition may be apparent in the adipose tissue of the heart. The cause of jaundice in adult sheep in New Zealand is most commonly the result of severe sporidesmin intoxication or ingestion of ragwort (*Senecio jacobaea*).

Most infectious febrile conditions and toxicities result in degenerative changes in the myocardium, or myocarditis. Degeneration of the myocardium is seen in the cardiac form of white muscle disease although this condition has no public health significance, and myocardial changes are accompanied by a swollen, congested liver and excess fibrin in body cavities (Manktelow, 1984).

C. ovis may be occasionally detected in the hearts of adult sheep which is considered a site of predilection along with the diaphragm (Heath *et al*, 1985)

Enzootic pneumonia and other infections of the lung may extend to pleuritis and frequently to pericarditis/epicarditis while miscellaneous conditions of the heart include imperfect bleeding (in which there is congestion with the left ventricle full of blood), agonal haemorrhage resulting from electrical stunning, and melanosis.

Histopathological lesions have been recorded in the heart in sheep that have been subjected to acute but not fatal exposure to sodium monofluoroacetate (1080) with inflammation, necrosis, and scattered foci of fibrous tissue in the myocardium. (Gooneratne *et al*, 2008)

3.4.12 Risk profile

Disease processes of the heart will almost always be associated with bacteraemia or septicaemia with obvious changes throughout the carcass and/or viscera, and normal public health judgements will apply.

Any acute change in the pericardium is unlikely to occur without concurrent pathology in the epicardium and myocardium. Chronic cases of pericarditis and epicarditis which have the remote possibility of harbouring bacteria of possible public health significance will be invariably detected by examination of the heart rather than the pericardium.

Chronic inflammatory tissue restricted to the pericardium is of no public health significance.

3.4.13 Post mortem examination considerations

The best practice during evisceration of the adult sheep is for the pluck (lungs, heart and diaphragm) to be removed from the carcass with as much of the diaphragm as possible, and for examination of these organs to be carried out on the viscera table.

In New Zealand palpation of the heart and diaphragm has primarily been to detect *C. ovis* since the heart is one site of predilection. NZFSA trials in lambs have shown that palpation adds significantly to detection rates for *C. ovis*. NZFSA studies in lambs have shown that the heart is a poor indicator of further infestation by this parasite in the carcass.

Palpation of the pericardium, as currently prescribed is impractical and provides no public health or suitability benefit.

3.4.14 Recommendation

For public health purposes, the heart and pericardium should be viewed after the pericardium has been opened,

For suitability purposes the heart should be palpated.

3.5 Kidneys

3.5.1 New Zealand examination procedures

The New Zealand adult sheep examination procedures require that the kidneys be examined by viewing and palpation after enucleation.

3.5.2 International examination procedures

The US requires that the kidneys be examined by viewing and palpation on the carcass.

The EU requires the kidneys to be examined by viewing only; with incision, if necessary, of the kidneys and the renal lymph nodes. The kidneys are not required to be enucleated but removed from their fatty covering.

Australia and Canada requires the kidneys to be examined by viewing, with only Australia requiring enucleation prior to examination.

3.5.3 Hazard identification

There are no specific hazards food-borne hazards associated with abnormalities of the kidneys other than renal involvement with bacteraemia and septicaemia. Localised abnormalities may possibly involve zoonotic pathogens, as may other viscera, but these are considered rare and not restricted to the kidneys. Leptospirosis is not a food-borne zoonosis.

The kidneys, in their role of filters of the circulatory system, are likely to contain any organisms that have produced a systemic disease in the live animal. Generalised conditions such as bacteraemia or septicaemia and toxemia will often result in some parenchymous degeneration of the kidneys. In the case of a suspected toxemia or septicaemia, specific bilateral changes that may occur which are identifiable by organoleptic post mortem examination, include cloudy swelling, fatty degeneration and petechial haemorrhages.

Nephritis has many aetiologies and the inflammatory lesions may involve either the glomeruli and tubules or the interstitial tissue. The pathological process is likely to be either acute or subacute, suppurative or non-suppurative and focal or diffuse. Infection by *Clostridium perfringens* type D which causes an enterotoxaemia and widespread vascular damage is not common in adult sheep and unlikely to be observed in an animal presented for slaughter

3.5.4 Abnormal conditions not associated with hazards

Uraemia may be a consequence of nephritis, is usually detected by a strong urinous carcass odour and will result in condemnation of the carcass and viscera.

Pyelonephritis is a sporadic condition in sheep and most often occurs after parturition as an ascending infection from the bladder. The most common causative agents are the *Corynebacterium renale* group of bacteria, including *C renale*, *C cystitidis*, and *C pilosum*, as well as *Escherichia coli*. The condition may be unilateral (Jubb and Kennedy 1972) and post mortem findings include multiple small abscesses on the surface that may extend into the cortex and medulla.

Infections by *Leptospira interrogans* occur in sheep in New Zealand and they include the serovars *ballum*, *copenhageni*, *hardjobovis* and *pomona* (Hathaway, 1981 and Ridler, 2008). One recent survey indicated that around 1% of slaughtered lambs were potentially shedding leptospires with the serovar *hardjobovis* being more commonly isolated than the serovar *pomona* (Ridler, 2008). Ovine infection by leptospires may constitute an occupational hazard to meat workers but there is no evidence that such organisms can be considered a foodborne zoonosis.

Specific causes of generalised anaemia and/or haemolytic jaundice in adult sheep in New Zealand include leptospirosis, ovine white muscle disease, facial eczema, infection by *Eperythrozoon ovis*,

nutritional haemoglobinuria and chronic copper poisoning. Along with the generalised gross pathology, organoleptic changes may often be observed in the kidneys.

White spots and scars of variable shape and size are one of the most common pathological findings in adult sheep kidneys during post mortem examination. The white spots represent chronic, mainly multifocal inflammation of the cortical interstitium with the pattern of spots suggesting haematogenous spread of the pathogen. The majority of cases have associated tubular and glomerular lesions. Recent work with lamb kidneys in New Zealand has not demonstrated a strong predictive value of white spotted kidneys for serological evidence of infection by leptospirosis (Dorjee, 2009).

Kidneys of adult sheep very rarely involve a neoplasm such as a nephroblastoma (Headley, 2006) which are readily apparent upon observation.

Congenital retention cysts are occasionally observed in adult sheep kidneys. These are aberrant renal development malformations that contain urine and do not present any risk to human health.

Hydronephrosis is a condition that results from mechanical obstruction to the flow of urine through the ureter which results in dilation of the ureter and renal pelvis, partial obliteration of renal parenchyma and the formation of a large thin-walled cyst containing urine. Almost all cases of hydronephrosis detected are unilateral and of no consequence to the disposition of the carcass.

Neoplasms have been rarely reported in the kidneys of adult sheep (Webster, 1966) with the lesions presenting as sharply- defined pale, greyish nodules of lymphoid tissue confined to the renal cortex that are pea-sized, more or less uniform and bilaterally distributed in both kidneys.

Abnormal colour is occasionally seen and most involve an almost black kidney which is believed to be an accumulation of bilirubin. Chronic cases of phalaris poisoning (*P.tuberosa* and *P. arundinacea*) have been reported as resulting in a greenish pigmentation confined to the medulla (West *et al*, 2002). Unless any other discolouration of the carcass and viscera is present, these kidneys are condemned and the carcasses passed.

Urolithiasis is a pathological condition occasionally seen in sheep with the presence of urinary calculi in the bladder. This has been reported to be more common in drier farming conditions when grain based supplements have been fed to stock (Hungerford, 1975) and in some sheep, the presence of calculi has been associated with soft, flabby and pale kidneys.

Melanosis is a congenital condition that may be seen adjacent to the sacrum and vertebral column, and under pleura overlying ribs and intercostal muscle as well as in the liver and cortex of the kidneys.

3.5.5 Risk profile

The public health importance of lesions that are restricted to kidneys is not easily evaluated. The most frequent pathology seen in kidneys of adult sheep slaughtered in New Zealand is focal interstitial nephritis. There are no specific hazards food-borne hazards associated with renal abnormalities other than renal involvement with bacteraemia and septicaemia,

In a previous NZFSA study, petechial haemorrhages in the kidney that were concurrent with some pathological changes in other organs or tissues, were all taken as presumptive evidence of septicaemia or toxemia. This is now considered to be a very conservative judgement and it is probable that almost all cases so designated did not represent systemic disease.

The maximum permissible limit for cadmium in the kidneys of sheep in New Zealand is 2.5 mm/kg. As a consequence of New Zealand's history of farm fertiliser application and that both the liver and kidneys are sensitive to soil cadmium levels, the sale of ovine kidneys for human consumption from animals older than 30 months for human consumption is currently not permitted. This is described in Manual 16, Appendix 4, Disposition Table, where kidneys from ruminants (excluding deer) with six or more permanent incisors must be saved at pet food only. Most sheep acquire their fifth and sixth permanent incisors between the age of 30 and 36 months (West *et al*, 2002)

Although the cadmium restrictions on human consumption of kidneys from sheep older than 30 months would allow the collection of kidneys from those sheep with less than six permanent incisors, all kidneys from sheep other than lambs in New Zealand are collected for pet food. This eliminates the possibility of kidneys themselves constituting a direct risk to the consumer and restricts the purpose of post mortem examination as to whether the kidneys indicate a disease elsewhere in the viscera or carcass.

3.5.6 Post mortem Inspection considerations

The competent authorities of New Zealand and Australia are the only two of the international group under consideration that specify that the kidney shall be enucleated prior to examination. New Zealand and the US are the only two competent authorities that require the kidneys to be palpated.

NZFSA trial work carried out during the evaluation of inspection procedures for lamb kidneys demonstrated that lifting the kidneys from the viscera table and viewing both sides improved the sensitivity of inspection for all abnormalities when compared to visual examination on the viscera table alone (Hathaway and McKenzie, 1990). There was no value in palpating the kidneys.

Occasionally the kidney is partially obscured by renal fat, particularly in the carcasses of ewes in good condition, and this fat cover should be removed prior to examination.

3.5.7 Recommendation

While there is little scientific evidence for enucleation of the kidneys prior to examination for public health purposes, it is recommended that this practice should continue as an interim presentation requirement.

For public health purposes, the enucleated kidneys should be lifted from the viscera table and viewed.

When not saved as edible, the kidneys should be viewed without lifting on the table.

Liver and hepatic lymph nodes

3.5.8 New Zealand examination procedures

The New Zealand adult sheep examination procedures require that both the parietal and visceral surfaces of the liver and the bile duct be inspected by palpation and visual examination, especially the umbilical fissure for both edible and inedible livers. The procedures require that the hepatic lymph nodes be examined by viewing and palpation.

3.5.9 International examination procedures

The US inspection procedures require that both the parietal and visceral surfaces of the liver be inspected by palpation and visual examination. The bile duct and contents are to be observed and the gall bladder expressed for the detection of the fringed tapeworm (*Thysanosoma actinoides*) which does not occur in New Zealand. There is no particular requirement to examine the umbilical fissure or the hepatic (portal) lymph nodes.

Canada requires both surfaces of the liver to be examined by viewing and palpation although there is no particular requirement for the umbilical fissure to be viewed or palpated. The procedures require the hepatic lymph nodes to be incised and examined and the bile ducts to be opened and examined.

The EU inspection procedures require visual inspection and palpation of the liver and the hepatic lymph nodes (Lnn. portales). The gastric surface of the liver is to be incised to examine the bile ducts. There is no particular requirement for the umbilical fissure to be viewed or palpated nor is there any specific requirement to view the gall bladder.

Australia requires the liver to be examined by palpation only. There is no particular requirement for the umbilical fissure to be viewed or palpated nor is there any requirement to view the gall bladder. The procedures require the main bile ducts to be incised transversely, the contents observed and the hepatic (portal) lymph node to be observed.

3.5.10 Hazard identification

There are no specific hazards associated with particular abnormalities of the liver. Localised abnormalities, such as abscesses may possibly involve zoonotic pathogens, as may other viscera, but these are considered rare and not restricted to the liver. The liver is regarded as a significant repository of circulating pathogens and can be expected to contain any organisms that have produced a systemic disease in the live animal.

Inflammation of the liver can lead to a range of gross pathological changes and the associated hepatitis may be acute or subacute, suppurative or non-suppurative, focal or diffuse. Hepatitis is rarely reported in adult sheep. Jaundice and anaemia are generalized conditions that may be assessed on the changes observed in the entire carcass and viscera. Chronic cirrhosis is a common finding at post mortem and in New Zealand is usually the result of sporidesmin intoxication (facial eczema).

Diffuse and focal bacterial hepatitis is occasionally found at post mortem inspection, and *Fusobacterium necrophorum* can cause severe focal necrosis. Infection by *Salmonella* spp. has also been reported as causing an enlarged fatty liver with an extended gall bladder (West *et al*, 2002)

Generalised conditions such as bacteraemia or septicaemia and toxemia will often result in parenchymous degeneration. Changes in size, colour, consistency and structure are important indicators when differentiating between localized and systemic conditions. The liver may exhibit cloudy swelling or even fatty degeneration with more severe injury. There are often many small foci of infection and in severe cases; the liver may be soft and pulpy with numerous areas of necrosis

3.5.11 Abnormal conditions not associated with hazards

Parasitism of adult sheep by *Fasciola hepatica* is not uncommon in New Zealand and the immature flukes reach the liver after migrating via the intestinal wall and peritoneal cavity. In the acute disease, the liver is enlarged and mottled with haemorrhagic tracts and subcapsular haemorrhages (West *et al*, 2002) while in the commonly seen chronic form, the liver is typically hypertrophied with varying degrees of bile duct thickening. Mature flukes are frequently found within the bile ducts.

Lesions caused by the parasite *C. tenuicollis* include larval tracts, spots and scars which are variable in their appearance, ranging from acute haemorrhagic larval tracts to chronic mineralization of scar tissue, depending on their stage of pathogenesis. The cysts may be superficial or embedded in the liver parenchyma.

Poisoning by ingestion of blue lupin (*Lupinus angustifolius*) has been reported in New Zealand (Connor, 1977) with the mycotoxin that produces the progressive liver damage being produced by the parasite

Phomopsis leptostromiformis (West *et al*, 2002). In sheep, lupinosis produces chronic hepatic lipoidosis and fibrosis (Hungerford, 1975)

Ingestion of fresh-water blue-green algae has been reported as causing liver damage, jaundice and photosensitization in sheep (West *et al*, 2002)

The condition of Ovine White Liver Disease has been reported in New Zealand but is usually associated with young sheep. It is believed to be a mycotoxicosis, which only causes lesions in cobalt deficient areas that result in a fatty swollen liver (West *et al*, 2002).

Neoplasia is occasionally recorded in the liver of adult sheep. This may include hepatic haematoma, lymphoma and bile duct cystoma. Hepatocellular carcinoma and cholangiocellular carcinoma have also been reported in aged ewes (Mohajeri *et al*, 2008). B-cell leukaemia with a diffusely enlarged, dark-red friable liver has been reported in one aged ewe (Valentine and McDonough, 2003).

Melanosis is a congenital condition seen in the liver as black patches on the surface. It is not usually restricted to the liver and may also be seen adjacent to the sacrum and vertebral column, and under pleura overlying ribs and intercostal muscle, as well as in the cortex of the kidneys.

Anaplasmosis, which may cause changes to bile and the gall bladder, has not been reported in New Zealand.

The overall prevalence of abnormalities found in the hepatic lymph nodes of adult sheep in New Zealand is very low. The most common abnormalities detected in the hepatic lymph nodes include enlargement, abscessation and calcification. Further histopathological examination of enlarged hepatic lymph nodes has demonstrated a very poor correlation between abnormal size and histological evidence of reactivity with more than 60% of enlarged nodes being histologically normal (Hathaway and McKenzie, 1990). The reactive nodes have been associated with parasitic infection, facial eczema, multiple abscesses and white-spotted liver and all of these conditions were readily apparent in the liver upon observation.

3.5.12 Risk profile

The liver is the first organ to show gross pathological changes in cases of systemic disease or intoxication, and is often the last organ to complete the repair process (Jubb and Kennedy, 1972) and so has obvious importance in terms of post mortem examination for public health purposes. In some instances, the gross pathological lesions are pathognomonic for specific diseases and defects, however no specific associations between food-borne pathogens and particular abnormalities of the liver are recognised. Despite the theoretical importance of the liver as an indicator of systemic disease, past studies in lambs have shown that the liver is very rarely required as an indicator to assist in making a disposition for systemic pathological conditions arising in the liver or elsewhere (Hathaway and McKenzie, 1990).

The ovine liver is sometimes saved for human consumption and so both possible public health and suitability must be considered. In New Zealand, the major causes of rejection from edible status are cirrhosis from facial eczema and parasitism. Isolated parasitic cysts (*C. tenuicollis*) are usually trimmed by inspection staff (up to six or less such lesions per liver) while livers showing evidence of infection by *Fasciola hepatica* are directed to pet food or condemned on grounds of suitability despite the lack of risk to the consumer. Livers that display more than minor cirrhosis from facial eczema are condemned on aesthetic grounds.

The hepatic lymph nodes receive afferent ducts from the liver as well as some afferent ducts from the pancreas, duodenum and abomasal lymph nodes. Reactive lymph nodes usually represent the presence of antigens from a variety of sources. As shown above, the liver is affected by a wide range of pathological conditions and these are invariably detected by examination of the liver rather than examination of the hepatic lymph nodes.

3.5.13 Post mortem examination considerations

The liver is one organ of the adult sheep that all competent authorities in the quadrilateral countries and the EU require to be examined by viewing and palpation

Past studies have demonstrated that palpation of both sides of the liver in lambs has contributed to a small reduction in the non-detection rate of defects that relate to suitability rather than public safety (Hathaway and McKenzie, 1990).

All of the above conditions are apparent by observation with the exception of deep seated abscesses in a liver without any superficial lesions.

In New Zealand, the most common abnormality encountered in the liver of adult sheep is infestation of the main bile duct with *Fasciola hepatica* and studies carried out with lamb livers indicated that viewing and palpation was nearly as effective as incision and viewing of the bile duct in detecting the parasite (Hathaway and McKenzie, 1990).

3.5.14 Recommendations

For public health purposes, both the parietal and visceral surfaces of liver including the bile duct should be examined by viewing and palpation, and the hepatic lymph nodes should be viewed.

The degree of palpation required should be that sufficient to hold and rotate the organ.

When not saved as edible, the liver, bile duct and hepatic lymph nodes should be viewed.

3.6 Lungs, trachea and associated lymph nodes

3.6.1 New Zealand examination procedures

The New Zealand adult sheep examination code requires that the lungs and bronchial lymph nodes be inspected by palpation and visual examination while the mediastinal lymph nodes are to be examined by palpation only. The trachea is to be viewed with the proviso that the trachea is not to be saved for human consumption if lung abnormalities that could involve the trachea are observed.

3.6.2 International examination procedures

The US inspection procedures require the costal surface of the lungs to be examined by viewing and palpation while the ventral surface is to be examined by viewing only. The bronchial and mediastinal lymph nodes are to be palpated, and there is no specific inspection requirement for the trachea. Edible lungs are not permitted in the US.

The EU require the lungs to be examined by viewing and palpation, and the bronchial and mediastinal lymph nodes to be examined by palpation; in the event of doubt both the lungs and associated lymph nodes must be incised and examined. The trachea is required to be viewed.

Canada requires the lungs to be examined by palpation. There is no specific requirement to examine the bronchial, mediastinal lymph nodes or the trachea.

The Australian inspection procedures require palpation of the lungs, bronchial and mediastinal lymph nodes and have no specific requirement to inspect the trachea. Where the lungs are saved for human consumption, the bronchi are to be opened and the internal surfaces observed.

3.6.3 Hazard identification

There are no specific hazards associated with particular grossly observable abnormalities of the lungs, trachea or associated lymph nodes. Localised abnormalities, such as pulmonary abscesses may possibly involve zoonotic pathogens, as may other viscera, but these are considered rare and not restricted to the lungs. The lungs are regarded as a significant repository of circulating pathogens and may contain any organisms that have produced a systemic disease in the live animal.

Cryptococcosis neoformans var. neoformans has been reported from an ovine lung sample and histopathology of the specimen indicated destruction of columnar respiratory epithelium architecture associated with suppuration (Lemos *et al*, 2007)

Infection of adult sheep by *Salmonella* spp. has been reported as causing moderate to severe congestion of the lungs (West *et al*, 2002).

Abscesses may develop from any case of suppurative pneumonia with possible pathogens including *Staphylococcus* spp. and *Streptococcus* spp. Infection by *Corynebacterium ovis* also has been recorded which typically presents as sub-clinical, with abscesses in the lungs and associated thoracic (bronchial and mediastinal) lymph nodes (O'Reilly, 2008) with such infections more common with advancing age (West *et al*, 2002).

Routine examination of the bronchial and mediastinal lymph nodes of slaughtered animals in traditional inspection systems is largely justified as a means of detecting chronic granulomatous conditions such as infection with *Mycobacterium bovis* (Thornton and Gracey, 1974). Such infections have not been recorded in the bronchial and mediastinal lymph nodes of sheep in New Zealand since 1979 (Cordes *et al*, 1981) and with recent progress made towards the eradication of this disease from cattle in New Zealand, such ovine infections are very unlikely to be encountered in the future

3.6.4 Abnormal conditions not associated with hazards

Lung pathology is a very common post mortem finding in adult sheep with many exhibiting some evidence of pneumonia and pleurisy. In New Zealand approximately a quarter of all slaughtered adult sheep are recorded as having sufficient lung pathology to warrant the carcass being detained for trimming and reinspection (ASUREQuality database 2001-2008). Acute generalised inflammation of the lungs or pleura invariably results in total condemnation of the carcass, even if no systemic pathological changes are detected in the carcass or viscera.

There are many pathogens that have been isolated from the upper and lower respiratory tracts of adult sheep although the specific aetiologies may not be well understood. Enzootic pneumonia is the most common lung pathology seen in adult sheep and this frequently progresses to pleurisy and even pericarditis. Microorganisms that are believed to be involved in the pathogenesis of enzootic pneumonia in sheep include *Pasteurella (Mannheimia) haemolytica*, *P. haemolytica* type T, *P. multocida*, *Bordetella parapertussis*, *Mycoplasma ovipneumoniae* and *M. arganini*, *Parainfluenza* virus type 3, Respiratory syncytial virus, Ovine adenovirus type 6 and Bovine adenovirus type 7 (West *et al*, 2002). Of these, *Pasteurella (Mannheimia)* is considered to be the most frequent cause of lung pathology to sheep in the aetiology of both acute fibrinous pneumonia which occurs in sheep of all ages and chronic non-progressive pneumonia which is more frequently observed in young sheep. Other viruses known to cause pulmonary pathology in sheep include Bluetongue, Peste-des-petits-ruminants, and Sheepox viruses (Ozmen *et al*, 2008) but none of these are recorded as being in New Zealand.

Micro-organisms that have been isolated from the bronchial and mediastinal lymph nodes of lambs in New Zealand include; *Corynebacterium pseudotuberculosis* (ovis), *C. pyogenes*, *Actinobacillus* spp., *Staphylococcus aureus* and *E. coli* (Hathaway and McKenzie, 1990)

The condition of pleurisy is generally not regarded as an entity in itself but as a progression of pathology that has begun in the parenchyma of the lungs. It is believed that pleurisy in ovines often follows subclinical pneumonia and that secondary invasion by bacteria is the major cause of the pleural lesions. Acute fibrinous pneumonia caused by *P. haemolytica* type A is a specific ovine disease and this organism has also been incriminated in subacute and chronic pneumonia.

Infection of a six month old lamb by *Helcococcus ovis* has recently been reported from the US with gross pathology including severe, focally extensive, chronic necrotizing pleuritis with intra-lesional coccobacilli and mild, multifocal, subacute mucopurulent bronchopneumonia, although the clinical significance of this organism in sheep has not been reported (Zhang *et al*, 2009).

Acute and long-term effects of exposure to sodium monofluoroacetate (1080) in sheep has been reported as producing histopathological lesions in the heart and lung with inflammation, necrosis, and scattered foci of fibrous tissue in the myocardium, pulmonary oedema and inflammation of the lung. No adverse long-term effects on general health were observed in any sheep that survived the first 4 days following exposure to 1080.(Gooneratne *et al*, 2008)

Multifocal parasitic granulomata were the most commonly reported findings in the pulmonary lymph nodes in one study carried out in New Zealand (Hathaway and McKenzie, 1990) although the majority of these lesions required incision for their detection. None of these lesions had any public health significance. Other findings recorded in the same study included, reactive nodes, lymphadenitis, abscessation, fibrosis, a calcified nodule and melanosis.

Reactive lymph nodes usually indicate both the competence of a functioning immune system as well as the presence of antigens from a wide variety of sources. However reactive lymph nodes are often difficult to differentiate from those that are at the upper end of the normal range with the wide variation in size, shape and colour of normal lymph nodes making the gross diagnosis of moderately-reactive nodes difficult (Monlux and Monlux, 1972; Ladd, 1972; Shutang, 1986).

Neoplasms are rarely recorded as occurring in the lungs of adult sheep in New Zealand but overseas, the condition known as ovine pulmonary adenocarcinoma has been reported as being associated with infection by Jaagsiekte retrovirus (Philbey *et al*, 2006) . A plasmacytoma that had metastasized from the mediastinal lymph nodes to the lungs in an old sheep has also been reported (Perez *et al*, 2000).

Parasitic pneumonia is generally recognisable in sheep with *Dictyocaulus filaria* usually causing small brown areas of bronchopneumonia. These lungworms usually affect the diaphragmatic or caudal lobes whereas enzootic pneumonia is mainly confined to the anterior and ventral lobes (West *et al*, 2002).

Muellerius capillaris infection may be found producing yellow-brown or grey shot like nodules throughout the parenchyma with green patches (Hungerford, 1975).

3.6.5 Risk Profile

The lungs of adult sheep are frequently found to have abnormalities. However, no specific associations between food-borne pathogens and particular abnormalities of the lungs are recognised.

Lung abnormalities with concurrent involvement of the associated lymph nodes and/or other tissues could be considered possible public health risks if the lungs were intended for human consumption and so when making carcass and viscera dispositions, the following conditions must be considered; lung pathology and concurrent systemic pathology ; acute, generalised lung pathology and concurrent involvement of the associated lymph nodes; acute, localised lung pathology and concurrent involvement of the associated lymph nodes; and specific lung pathology that may affect the disposition of the whole viscera and carcass

3.6.6 Post mortem examination considerations

Almost all ovine lungs in New Zealand are not saved for human consumption and thus localised pathology falling outside the above categories of is of little consequence, unless it is used as a specific indicator for abnormalities that may occur elsewhere. Studies by Hathaway and McKenzie (1990) indicated that pathology that was restricted to the thoracic lymph nodes had no indicator function for the disposition of the carcass or remaining viscera. These studies regarding the performance characteristics of different inspection methods for the detection of abnormalities in the lungs of over 30,000 lambs also indicated that palpation provided a very limited contribution to the detection of all abnormalities (Hathaway and McKenzie, 1990). The performance characteristics of the two inspection methods are likely to be similar for the examination of adult sheep lungs.

Any abnormalities detected in the bronchial or mediastinal lymph nodes were at a significantly lower prevalence than those detected in the lungs. For cases of lung abnormalities that were found to have a concurrent involvement of the associated lymph nodes, these were detected by viewing. These changes to the pleural parenchyma were readily apparent without the need to palpate the lungs.

Studies in New Zealand have demonstrated that routine viewing or palpation of the bronchial and mediastinal lymph nodes in the absence of gross lung pathology had no indicator function.

3.6.7 Recommendation

For public health purposes, the lungs and bronchial lymph nodes should be viewed and palpated, the mediastinal lymph nodes should be palpated and the trachea viewed.

If intended as inedible, both surfaces of lungs should be examined by viewing.

Pancreas

3.6.8 New Zealand examination procedures

The New Zealand adult sheep examination code requires that the pancreas be inspected by visual examination.

3.6.9 International examination procedures

The US and Australia require the pancreas to be examined only when saved for human consumption.

Canada and the EU have no requirement for the pancreas to be examined.

3.6.10 Hazard identification

There are no specific abnormalities of public health importance found in the pancreas.

3.6.11 Abnormal conditions not associated with hazards

Pancreatic lesions involving necrosis of the pancreatic duct epithelium followed by oedema, lobular cystic changes, atrophy, fibrosis and ductular hyperplasia has been reported in sheep that have been regularly dosed with zinc oxide three times a week for four weeks (Smith and Embling, 1993). This level of ingestion of zinc oxide is far in excess of what is likely to be given as a prophylactic against sporodesmin toxicity under New Zealand farming conditions.

3.6.12 Risk profile

Abnormalities are very rare in the pancreas and are usually limited to changes seen during a systemic condition such as congestion and /or hyperaemia which will be readily apparent elsewhere in the carcass.

3.6.13 Post mortem examination considerations

New Zealand is the only country in the Quadrilateral Group and the EU that requires routine examination of the pancreas. The absence of any indicator function and the routine removal from human consumption of the pancreas indicates that the current requirement for examination is unwarranted.

3.6.14 Recommendation

If saved for human consumption the pancreas should be viewed for suitability purposes.

3.7 Pizzle

3.7.1 New Zealand examination procedures

The New Zealand examination code for adult sheep requires that the pizzle be examined by visual examination and palpation when saved for human consumption

3.7.2 International examination procedures

The US, Canada have no post mortem requirements for the pizzle

The EU requires the pizzle to be inspected by viewing only.

Australia requires the pizzle to be observed when recovered for human consumption only.

3.7.3 Hazard identification

There are no specific abnormalities of public health Importance affecting the pizzle

3.7.4 Abnormal conditions not associated with hazards

The most common condition affecting the penis and prepuce of rams in New Zealand is balano-posthitis or pizzle rot (West *et al*, 2002). The condition is caused directly by a bacterium, usually *Corynebacterium renale*, which grows profusely in alkaline urine. Such urine is produced readily by sheep fed a protein rich diet. Lesions on the penis are generally confined to swelling and necrosis in severe cases which are readily apparent.

Ovine herpesvirus type 2 has been isolated from the penis of an ram affected by balanitis (Pritchard *et al*, 2008)

3.7.5 Risk profile

New Zealand does not have any specific abnormality of the ovine penis of public health significance.

3.7.6 Post mortem examination considerations

Very few adult male sheep are slaughtered for human consumption in the country.

Any abnormalities to be found in the penis of adult sheep are likely to be restricted to the distal end of the organ where the balanoposthitis will have been located. These changes will be visually obvious

3.7.7 Recommendation

If saved for human consumption, the pizzle should be viewed.

3.8 Spleen

3.8.1 New Zealand examination procedures

The New Zealand examination code for adult sheep requires that the spleen be inspected by visual examination and palpation

3.8.2 International examination procedures

The US, Canada and the EU require the spleen to be inspected by viewing only.

Australia requires the spleen to be inspected by palpation only.

3.8.3 Hazard identification

The spleen may constitute a specific pathological indicator in some livestock diseases but with regard to sheep, anthrax is the only disease where pathological changes in the spleen are symptomatic of the disease (Jubb and Kennedy, 1972). Anthrax is characterised by a very acute onset in sheep and clinically affected animals exhibiting gross pathology that may include splenic enlargement are very unlikely to be presented for slaughter. Anthrax has not been reported in New Zealand since 1954.

Localised conditions may rarely harbour zoonotic pathogens. These could include infarcts, haematomata, chronic peritoneal adhesions and abscesses. Septic emboli initially result in a haemorrhagic infarct that

will be visually obvious above the surface of the spleen. Abscesses in the spleen are generally the result of a bacteraemia.

Enlargement of the spleen has been observed along with other gross pathology in cases of anaemia and jaundice (Manktelow, 1984). Similarly, some degree of splenic enlargement has been noted in animals with leptospirosis, septicaemia, traumatic pericarditis, leukaemia and chronic salmonellosis.

3.8.4 Abnormal conditions not associated with hazards

Nodular hyperplasia has been reported in the spleen of aged ewes slaughtered in New Zealand (Jolly, 1967) with discrete lesions that were not accompanied by evidence of local invasion or secondary lesions in other organs or tissues. The defects are not considered to be of any significance to public health.

Generalised neoplasms of lymphoreticular origin have been reported in adult ewes aged five years or more at a prevalence of 1 per 10,000 animals (Webster, 1967) although the condition is extremely rare in younger sheep. Lesions of lymphomatosis are usually widespread prior to their detection, with visually apparent changes through out the carcass and viscera. Cordes and Shortridge (1971) reviewed 39 cases of lymphosarcoma in sheep and the predominant gross pathology occurred in the liver, kidneys and lymph nodes. In only four animals was there any gross pathology in the spleen.

Mild splenomegaly has been reported in an aged ewe diagnosed to have B-cell leukaemia (Valentine and McDonough, 2003) which also exhibited an enlarged liver and mesenteric lymphadenopathy.

Haematomata may be seen in all animals and are traumatic in origin, usually occurring as a result of injury during transport. Agonal haemorrhages resulting from electrical stunning are not uncommon which may also cause minor enlargement of the spleen.

3.8.5 Risk profile

The spleens of adult sheep in New Zealand are rarely found to have abnormalities and there are no specific food-borne hazards that are restricted to this organ.

3.8.6 Post mortem examination considerations

An evaluation of the examination procedures for the spleen of lambs was carried out in 1988 involving over 30,000 spleens (Hathaway and McKenzie, 1990). The prevalence of animals in which there was concurrent pathology in other viscera and/or the carcass was very low at 0.01% with all such cases being detected on the viscera table by viewing. This included cases where the carcass and viscera were condemned for gross emaciation, and the spleens showed gross evidence of secondary anaemic change. Visual examination was deemed to have a relatively high sensitivity for detecting abnormalities in the

ovine spleen. The study also concluded that the spleen did not provide any assistance in reaching dispositions for the accompanying carcass or viscera and thus examination of the spleen served no indicator function in lambs.

There is no indication that abnormalities of the spleen are more prevalent in adult sheep.

3.8.7 Recommendation

For public health purposes, the spleen should be viewed.

3.9 Testes

3.9.1 New Zealand examination procedures

The New Zealand examination code for adult sheep requires that the testes (including the epididymis) be inspected by visual examination and palpation when saved for human consumption only

3.9.2 International examination procedures

Australia requires the testes of adult sheep to be examined by observation only when saved for human consumption.

The US and Canada have no examination requirements for the testes of adult sheep.

The EU examination procedures require visual inspection of the genital organs irrespective of whether the organs are being saved for human consumption.

3.9.3 Hazard identification

There are no specific abnormalities of public health significance affecting the testes and epididymis.

3.9.4 Abnormal conditions not associated with hazards

Epididymitis is occasionally reported in adult rams and is likely to be caused by either *Brucella ovis*, *Actinobacillus seminis* or *Histophilus ovis* (West et al, 2002) During infection by *B.ovis*, after the bacteraemic phase, the organism usually localises in the epididymis and accessory sex glands and occasionally in the testes, kidneys, liver, spleen and lung although pathological changes are usually confined to the epididymis and accessory sex glands. Most gross lesions are located in the tail of the

epididymis and may measure up to 3 cm in diameter. The lesion may persist as a granuloma or develop into an abscess.

Epididymitis caused by *Actinobacillus seminis* or *Histophilus ovis* has been observed in ram lambs as young as 6 months of age with swollen testes and gross pathology includes abscesses in both the epididymis and testes. (West et al, 2002)

3.9.5 Risk profile

There have been no reported zoonotic conditions detected in ovine testicles or epididymis in adult sheep in New Zealand.

3.9.6 Post mortem examination considerations

The testes of adult rams are very rarely saved for human consumption in New Zealand as most aged rams are either slaughtered on the farm for dog food or sent to pet food premises.

Testes of younger ram lambs are generally preferred by the consumer. Although none of the organisms that have been identified in New Zealand that affect the testes and epididymis have been reported as being zoonotic; for suitability purposes, palpation of the testes and epididymis should be required to detect any deep seated abscesses in the testicular parenchyma and epididymis.

3.9.7 Recommendation

If saved for human consumption, the testes (including the epididymis) should be viewed and palpated for suitability purposes.

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Appendix 1

Disease and Defect Recording Requirements for *C.ovis*

Amendment 8: Manual 16

Date: 28 February 2008

Background

At the request of Industry, NZFSA has assessed the examination requirements for bovine lungs and for lamb diaphragms where *Taenia ovis* is detected. This assessment has resulted in the following changes:

1.1 Remove the recording and carcass re-examination requirement when *T. ovis* is detected in lamb diaphragms and add guidance for the collection of data via Ovis Management Ltd to enable control and management of *T. ovis* on farm.

2.1 Manual 16 is amended by deleting section 6.5 and inserting the following section:

Sheep and Lambs

Where *T. ovis* (*C. ovis*) cysts or Caseous lymphadenitis (CLA) lesions are detected anywhere in the viscera of the sheep (other than lambs), the carcass is to be diverted to the detain rail and the appropriate disease is to be recorded.

It is recommended that this requirement to divert the carcass of adult sheep to the detain rail if *C.ovis* is detected in the viscera be removed.

Appendix 2

Current and recommended post mortem examination procedures for adult sheep in New Zealand

Inspection Table – Amendment 12 – March 2010

Tissue	Current	Recommended	Inspection Table Notes
Abdominal cavity	VP	VP	
Abomasum	V	V	
Axillae	V	V	
Back carcass	VP	V	
Bile duct (e)	VP	VP	
Bile duct (i)	VP	V	
Brisket	V	V	
Bronchial Inn (e)	VP	VP	
Bronchial Inn (i)	VP	none	
Diaphragm	VP	VP	
Forelegs	V	V	
Front of hind legs	V	V	
Gastro-intestinal tract	V	V	
Head (e)	V	V	View the buccal cavity and the pharynx. The head does not need to be picked up.
Head (i)	none	none	If the head, tongue nor the brains are required for human consumption
Heart (e)	VP	VP	
Heart (i)	VP	V	
Hepatic Inn (e)	VP	V	
Hepatic Inn (i)	VP	V	
Iliac Inn	V	V	
Intestines	V	V	
Ischiatic Inn	P	V	
Joints	VP	V	
Kidneys (e)	VP	V	Enucleate first
Kidneys (i)	VP	V	Enucleate first
Liver (e)	VP	VP	The parietal and visceral surfaces. Especially the umbilical fissure.
Liver (i)	VP	V	The parietal and visceral surfaces. Especially the umbilical fissure.
Lungs (e)	VP	VP	
Lungs (i)	VP	V	
Mediastinal Inn (e)	P	P	
Mediastinal Inn (i)	P	none	
Mesenteric Inn (e)	VP	V	Palpate a representative proportion
Mesenteric Inn (i)	VP	V	Palpate a representative proportion
Neck	V	VP	
Oesophagus (e)	VP	V	
Oesophagus (i)	VP	V	
Omasum	V	V	

Omental fat	V	none	
Pancreas (e)	V	V	
Pancreas (i)	V	none	
Pelvic cavity	V	V	
Pericardium	VP	V	In conjunction with heart examination
Peritoneum, visceral	V	V	
Pizzle (e)	VP	V	
Pizzle (i)	none	none	
Popliteal Inn	P	P	
Rectal cavity	V	V	Put two fingers in the rectal cavity and pull the tail back. View the muscular groove on either side of the tail
Reticulum	V	V	
Rumen	V	V	
Spleen (e) & (i)	VP	V	
Subiliac Inn	VP	V	
Superficial cervical Inn	P	P	
Superficial inguinal Inn	VP	V	
Supramammary Inn	VP	V	
Testicles (e)	VP	VP	Including the epididymis
Testicles (i)	none	none	
Thoracic cavity	VP	V	
Thymus	V	V	
Tongue (e)	VP	V	
Tongue (i)	none	none	If the tongue, the head, nor the brains are required for human consumption
Trachea (e)	V	V	Open trachea and main branches of the bronchi. Inspect the lungs to edible standard
Trachea (i)	V	none	
Ventral surface abdomen	V	V	

Appendix 3

International comparison of current adult sheep post mortem examination procedures

Tissue	AUS	US	CAN	EU	NZ
Abdominal cavity	V	V	V	V	VP
Abomasum	none	none	none	none	V
Axillae	V	V	V	V	V
Back carcass	V	VP	V	V	VP
Bile duct (e)	IV	V	I	IV	VP
Bile duct (i)	IV	V	I	IV	VP
Brisket	V	V	V	V	V
Bronchial Inn	P	P	none	P	VP
Diaphragm	V	V	V	V	VP
Forelegs	V	V	V	V	V
Front of hind legs	V	V	V	V	V
Gastrointestinal tract	V	V	V	V	V
Head (e)	V	V	V	V	V
Head (i)	none	V	none	none	none
Heart (e)	P	VP	P	V	VP
Heart (i)	P	VP	P	V	VP
Hepatic Inn	V	none	I	VP	VP
Int.ilic Inn	P	P	P	V	V
Intestines	V	V	V	V	V
Ischiatic Inn	P	none	none	V	P
Joints	V	V	V	V	VP
Kidneys (e)	V	VP on c/c	V	V	VP
Kidneys (i)	V	VP on c/c	V	V	VP
Liver (e)	P	VP	VP	VP	VP
Liver (i)	P	VP	VP	VP	VP
Lungs (e)	PI bronchi	n/a	n/a	VP	VP
Lungs (i)	P	VP costal V ventral	P	VP	VP
Mammary glands	none	none	none	V	none
Mediastinal Inn	P	P	V	P	P
Mesenteric Inn	V	V	P	V	VP
Neck	V	V	V	V	V
Oesophagus	V	V	V	V	VP
Omasum	none	none	none	none	V
Omental fat	none	V	none	none	V
Pancreas	V (e)	V (e)	none	none	V
Pelvic cavity	V	V	V	V	V
Pericardium	none	none	none	V	VP
Peritoneum, visceral	none	none	none	V	V

Pizzle (e)	V	none	none	V	VP
Pizzle (i)	none	none	none	V	No
Popliteal Inn	P	P	none	V	P
Rectal cavity	V	V	V	V	V
Reticulum	none	none	none	none	V
Rumen	none	none	none	none	V
Spleen (e)	P	V on c/c	V	V	VP
Spleen (i)	P	V on c/c	V	V	VP
Subiliac Inn	P or E&D	V	P	V	VP
Superficial cervical Inn	P or E&D	P	none	V	P
Superficial inguinal Inn	P or E&D	P	P	V	VP
Supramammary Inn	P or E&D	P	P	V	VP
Testicles (e)	V	none	none	V	VP
Testicles (i)	none	none	none	V	No
Thoracic cavity	V	V	V	V	VP
Tongue (e)	V	V	V	V	VP
Tongue (i)	none	V	none	none	none
Trachea (e)	V	n/a	n/a	IV	V
Trachea (i)	none	none	none	V	V
Ventral surface abdomen	V	V	V	V	V

E&D: excise and discard without inspection

I: incise

P: palpate

V: view

Red highlight: where only New Zealand requires palpation and viewing as an examination procedure for that tissue.