Australian Government

Australian Quarantine and Inspection Service

Investigation into the reportable sheep mortality level on sea voyage from Fremantle, Western Australia to Kuwait, Bahrain and The United Arab Emirates, August 2009.

1. Purpose

To report on the investigation into the cause of mortalities in sheep exported by sea to Kuwait, Bahrain and The United Arab Emirates (UAE), and to make recommendations with the objective of reducing the likelihood of a recurrence.

2. Summary

There were two consignments of sheep on this voyage. In one consignment of 43,886 sheep loaded in Portland on 5 August 2009, there were 760 mortalities recorded which equates to a mortality rate of 1.73%. In the second consignment of 34,535 sheep loaded in Fremantle on 11 August 2009, there were 756 mortalities which equates to a mortality rate of 2.19%. This investigation only reports on the consignment of sheep that exceeded the reportable mortality limit of 2%. The main causes of mortality were enteritis and inanition; mortalities due to heat stress were also recorded. Stress prior to loading, and high temperature and humidity in the Persian Gulf, contributed to the mortality exceeding the reportable level.

3. Background

The investigation into the mortality was completed by reviewing the following information:

1. Report from the exporter
2. End of Voyage and daily reports from the AQIS accredited veterinarian (AAV) who accompanied the consignment on board the vessel.
3. Records from the AAV who prepared the consignment.
4. Report from the master of the vessel.
5. Report from the Australian Maritime Safety Authority (AMSA).
6. Report from the AQIS regional certifying officer.
7. Records from the registered premises.

Table 1 Chronology of events showing cumulative mortality (count and percentage) by day

Date	Day	Event	Cumulative voyage mortality count	Cumulative Mortality %
11/08/2009		34,535 Sheep loaded in Fremantle		
12/08/2009	1	16 Mortalities	16	0.05%
13/08/2009	2	32 Mortalities	48	0.14%
14/08/2009	3	49 Mortalities	97	0.28%
15/08/2009	4	46 Mortalities	143	0.41%

Date	Day	Event	Cumulative voyage mortality count	Cumulative Mortality %
16/08/2009	5	51 Mortalities	194	0.56%
17/08/2009	6	43 Mortalities	237	0.69%
18/08/2009	7	40 Mortalities	277	0.80%
19/08/2009	8	42 Mortalities	319	0.92%
20/08/2009	9	38 Mortalities	357	1.03%
21/08/2009	10	37 Mortalities	394	1.14%
22/08/2009	11	38 Mortalities	432	1.25%
23/08/2009	12	34 Mortalities	466	1.35%
24/08/2009	13	50 Mortalities	516	1.49%
25/08/2009	14	70 Mortalities	586	1.70%
26/08/2009	15	41 Mortalities Vessel arrived in Kuwait and commenced unloading sheep	627	1.82%
27/08/2009	16	25 Mortalities Unloading sheep in Kuwait	652	1.89%
28/08/2009	17	29 Mortalities Unloading in Kuwait completed, vessel departed Kuwait and sailed for Bahrain	681	1.97%
29/08/2009	18	15 Mortalities Vessel arrived in Bahrain and commenced unloading sheep	696	2.02%
30/08/2009	19	48 Mortalities Unloading in Bahrain completed, vessel departed Bahrain and sailed for UAE	744	2.15%
31/08/2009	20	12 Mortalities Vessel arrived in UAE and unloaded the remaining sheep	756	2.19%

The reportable mortality trigger for sheep is 2%, or 3 animals (whichever is greater). The reportable mortality level was triggered on day 18 of the voyage (29 August 2009) while the vessel was unloading sheep in Bahrain.

4. Findings

4.1 Preparation in the Registered Premise

The sheep exported from Fremantle were assembled at two separate registered premises. There were 42,909 sheep received at the first registered premises between 3 and 6 August 2009. In addition to this, there were 14,301 sheep remaining in the registered premises that were received previously, giving a total of 57,201 sheep resident in the registered premises.

There were 80 mortalities recorded in the registered premises during the assembly period, which equates to a mortality rate of 0.14%.

There were 1,692 sheep received at the second registered premises between 21 and 28 July 2009. In addition to this, there were 20 sheep remaining in the registered premises that had been received previously, giving a total of 1,712 sheep resident in the registered premises. There were 7 mortalities in the registered premises during the assembly period which equates to a mortality rate of 0.41%.

Of the sheep, 34,535 were loaded on the vessel. 10,042 of the remaining sheep in the registered premises were included in a consignment that was exported 7 days later on another vessel. The mortality in this consignment was 0.34% which is below the reportable level of 2%.

The report received from the exporter indicated that the sheep experienced a greater than normal level of stress during the assembly period. The exporter reported severe wet weather just prior to receival and throughout the assembly period. Due to the adverse weather, the sheep were wet when received and were housed in sheds to allow them to dry out prior to shearing and drafting. Because of this, many of the sheep were shorn and drafted close to the time of loading.

The reports received from the AQIS veterinary officers and the AQIS accredited veterinarian also noted the adverse weather conditions, and that the sheep were handled and shorn close to the time of loading, causing greater than normal levels of stress. One group of ram lambs was excluded from the consignment as they were showing signs of diarrhoea. There were no reports of diarrhoea in any other group, and there is no record of any other sheep being rejected from the consignment for diarrhoea or inappetence.

4.2 Loading onto the Vessel

The loading records indicate the stocking density of the sheep was in accordance with the Australian Standards for the Export of Livestock (ASEL). The records also indicate that the amount of fodder loaded was in accordance with the ASEL.

During loading, 232 sheep were rejected from the consignment by the AQIS accredited veterinarian. Reasons for rejection included lameness, injury, scabby mouth and eye problems.

4.3 Conditions during the Journey

Figure 1 shows the wet bulb temperature for each deck and each day, as well as the heat stress threshold (HST) and mortality limit (ML) for adult merino sheep. Heat stress threshold is the maximum ambient wet bulb temperature at which heat balance of the deep body temperature can be controlled using available mechanisms of heat loss. Mortality Limit is the wet bulb temperature at which the animal will die. For adult merino sheep the heat stress threshold is 30.6°C and the mortality limit is 35.5°C[1].

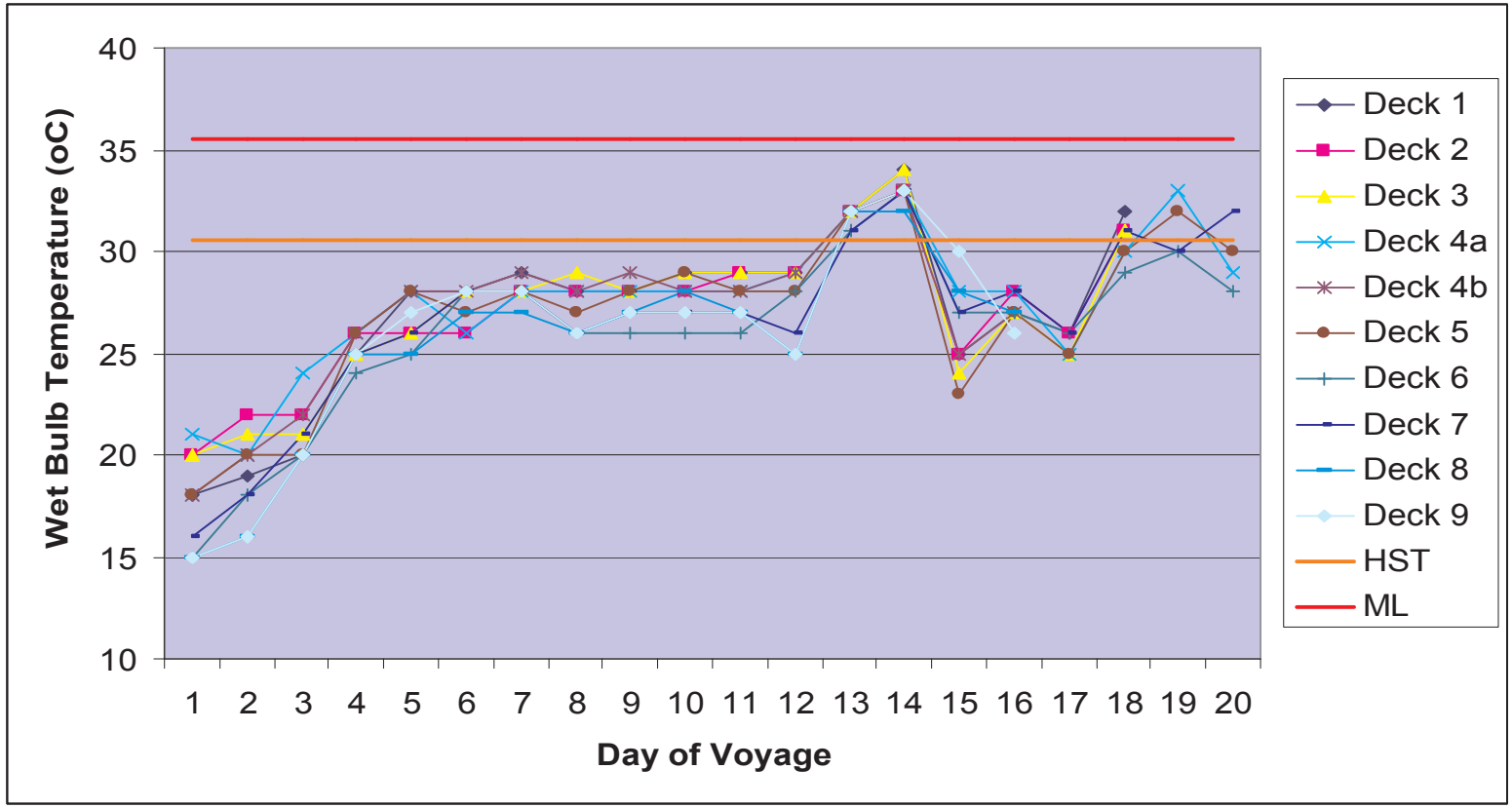

Figure 1 Wet bulb temperatures by deck and day, heat stress threshold (HST) and mortality limit (ML).

The available information indicates that the sheep were exposed to temperatures above the heat stress threshold on days 13 and 14 of the voyage as the vessel entered the Persian Gulf, and again on days 18 to 20 as the vessel discharged in Bahrain and the UAE. Figure 1 shows that the recorded wet bulb temperatures did not exceed the mortality limit on any deck on any day. However, the veterinarian's reports did record mortalities due to heat stress on days 13 and 14, and the veterinarian commented that the sheep most affected by the heat were those loaded in the center rows of the open decks and rams. It is not clear whether the sheep that died from heat stress were affected by any other condition that may have predisposed them to death from heat stress.

4.4 Mortality by Cause

Cause of mortality was reported on the veterinarian's daily reports and end of voyage report. Cause of mortality was not recorded for each individual deck. Post-mortems were performed each day, up to and including day 14 of the voyage. From day 15 onward, the vessel was in port discharging sheep and post-mortems could no longer be performed.

The veterinarian performed 501 post-mortem examinations during the voyage; a diagnosis was reached in 462 of these. Post-mortem examinations were not performed on sheep that died while the vessel was in port. The veterinarian reported the following causes of mortality; 69.91% (323) due to enteritis, inanition or a combination of the two, 19.91% (92) due to heat stress and 10.17% (47) due to pneumonia and other miscellaneous causes. Figure 2 shows the percentage of diagnosed mortality by cause for each category.

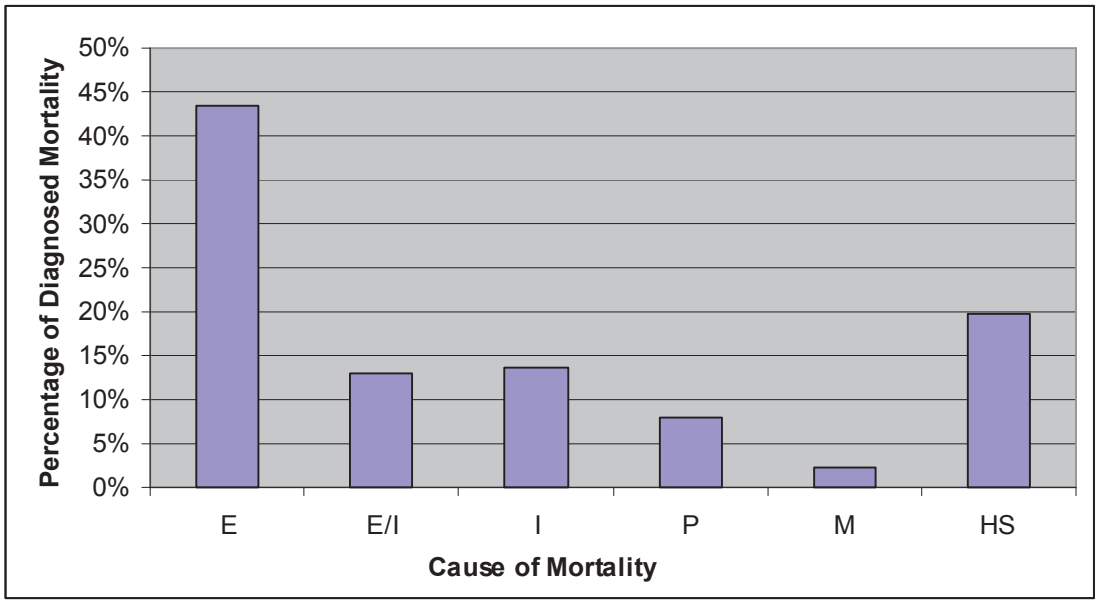

Figure 2 - Percentage of diagnosed mortality assigned to each cause

E = enteritis, E/I = enteritis and inanition, I = inanition, P = pneumonia, M = miscellaneous, HS = heat stress

4.5 Mortality by Day

Figure 3 shows the percentage of sheep that died each day (this is not a cumulative mortality) and the average wet bulb mortality across all decks of the vessel. The figure shows a clear spike in mortality associated with an increase in wet bulb temperature. It is important to note that mortality due to heat stress was only recorded on days 13 and 14. There is a second spike associated with the second increase in wet bulb temperature however, as no post-mortems were performed on these days it is not possible to determine if these deaths were due to primary heat stress or other causes.

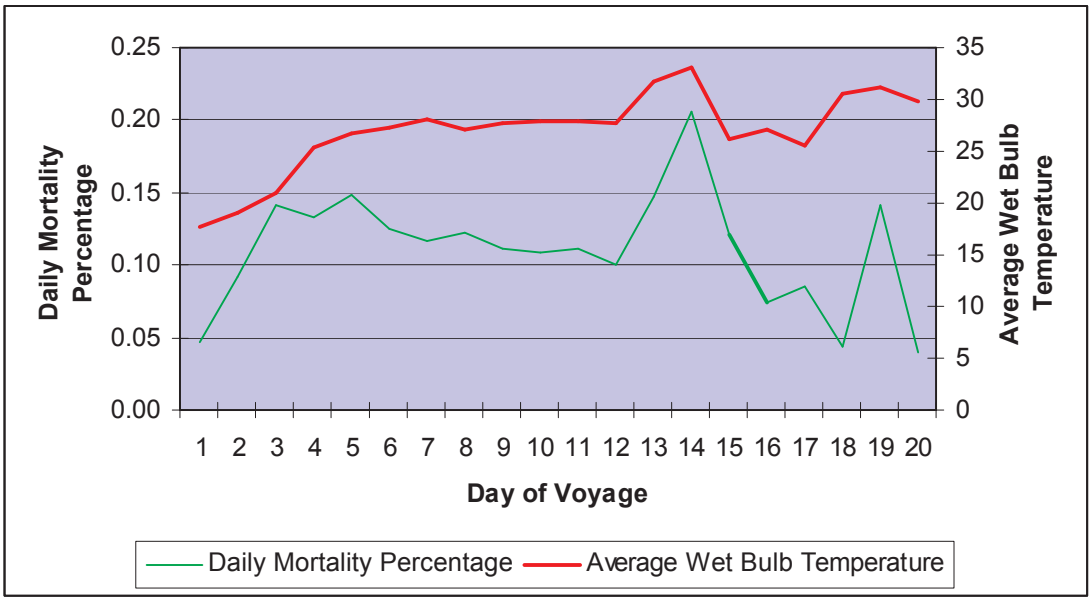

Figure 3 - Daily percent mortality and temperature

The green lines indicate the percentage of sheep that died each day (not cumulative)
The red line indicates the average wet bulb temperature across all decks

The veterinarian's reports indicate that enteritis was the dominant cause of mortality during the early stages of the voyage, with inanition increasing towards the end of the voyage. There was no clear pattern of mortality by day for pneumonia. Figure 4 shows daily percentage mortality by cause for the first 14 days of the voyage where post mortems were performed.

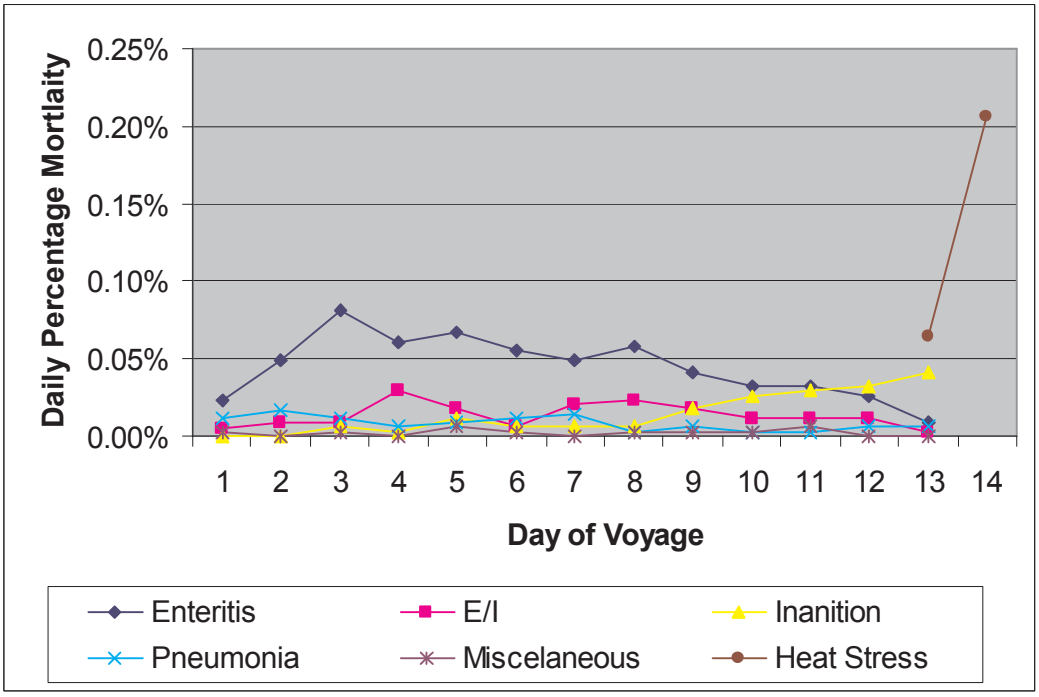

Figure 4 - Daily Percentage Mortality by Cause. The lines indicate the percentage of sheep that died from each cause on each day (not cumulative).

E/I = Enteritis and Inanition combined

4.6 Mortality by Class

Figure 5 shows the mortality percentage for each class of sheep. Class of sheep refers to the age and sex of sheep, i.e. lamb, ewe or ram as well as the commercial class of sheep, i.e. an A class wether is larger than a B class wether.

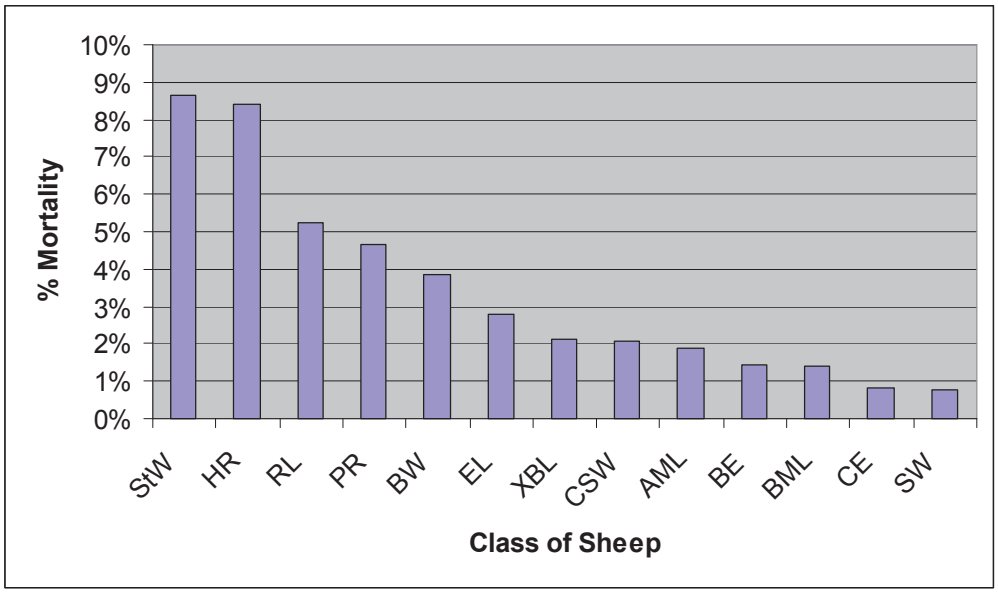

Figure 5 - Mortality percentages for each class of sheep arranged in order of decreasing mortality rate.

StW = Station Wether, HR = Horned Ram, RL = Ram Lamb, PR = Poll Ram, BW = B Class Wether, EL = Ewe Lamb, XBL = Crossbreed Lamb, CSW = C Class Special Wether, AML = A Class Merino Lamb, BE = B Class Ewe, BML = B Class Merino Lamb, CE = C Class Ewe, SW = Store Wether

The classes with the highest mortality rates were station wethers and all classes of rams. In addition to this the mortality in the B class wethers, ewe lambs, crossbreed lambs and the C-special wethers exceeded 2%.

The veterinarian's end of voyage report indicated that the station wethers, C-special wethers and lambs were most affected by enteritis and inanition while the rams and ram lambs were most affected by heat stress.

4.7 Mortality by Deck

Table 2 shows mortality by deck. Mortality rates were higher on the open two tiered decks than on the enclosed two tiered decks. Mortality rates were also higher on the lower tiers than on the upper tiers. As post-mortem results were not recorded by location it is difficult to determine if the variation in mortality rates was due to deck factors or due to sheep factors.

Table 2 Mortality by Deck

Deck	Tier	Number Loaded	Mortality Count	Mortality %
9	U	1,102	8	0.73%
9	L	3,821	82	2.15%
8	L	3,713	126	3.39%
7	U	2,183	28	1.28%
7	L	6,940	135	1.95%
6	U	5,406	71	1.31%
6	L	1,355	74	5.46%
5	Single	658	41	6.23%
4	U	1,361	41	3.01%
4	L	3,591	96	2.67%
3	U	950	13	1.37%
3	L	1,069	15	1.40%
2	U	625	5	0.80%
2	L	753	5	0.66%
1	U	543	2	0.37%
1	L	465	2	0.43%
Open Two Tiered Deck Total		24,520	524	2.14%
Closed Two Tiered Deck Total		9,357	179	1.91%
Upper Tiers Total		12,170	168	1.38%
Lower Tiers Total		21,707	535	2.46%
*Total**		34,535	744	2.15%

Note - Mortality by deck results were only available until day 19 of the voyage, final 12 mortalities not included in this table.
L = Lower Tier, U = Upper Tier

Decks 5 and 6 lower had the highest mortality percentage, the sheep on this deck were all rams and ram lambs. For the ram lambs, 31% of mortality was attributed to heat stress. A diagnosis was not reached for a majority of the ram mortalities (65.9%) as they occurred in port while post-mortem examination was not possible. The veterinarian, however, noted that the rams were the most heavily affected by heat stress.

High mortality was also noted on deck 8 lower. The station wethers were housed on this deck, and experienced the highest mortality percentage of all classes of sheep (8.63%) with enteritis, inanition and heat stress contributing to the mortality.

Mortality on deck 4 upper also exceeded 3%; all of the sheep on this deck were B wethers and C-special wethers. Both classes experienced mortality greater than 2% with enteritis, inanition and heat stress contributing to the mortality.

It is apparent that certain classes of sheep on certain decks experienced higher mortality than other sheep on other decks. There is insufficient information available to determine if these differences in mortality were driven by sheep factors, deck factors or a combination of the two.

5. AMSA evaluation of the vessel upon return to Australia

The AMSA evaluation of this vessel concluded that the vessel did not appear to suffer any failure of the livestock services during the voyage. The AMSA investigation included a full set of vent reading to ascertain if the ventilation was adequate. No inadequacies were identified.

6. Conclusion

The main causes of mortality were enteritis, inanition, and a combination of the two. Mortalities due to heat stress were also recorded. These results are consistent with existing knowledge on the causes of mortality in sheep exported live by sea[2,3]. For this voyage additional stress prior to loading, and high temperature and humidity in the Persian Gulf contributed to the mortality exceeding the reportable level. Mortality was highest in station sheep and rams. Mortality was also higher on open decks than on enclosed decks. There is insufficient information available to determine if these differences were driven by sheep factors, deck factors or a combination of the two.

7. Recommendations

a. AQIS to write to the LiveCorp technical working group requesting a review of ASEL standard 1.19 (c) to determine if shearing sheep in the 48 hours prior to export is acceptable, with a view to the technical working group preparing a paper for consideration by the Livestock Export Standards Advisory Group (LESAG).

b. AQIS to write to the LiveCorp technical working group requesting a review on whether the ASEL adequately addresses the risks for the export of rams on long haul voyages during Northern Hemisphere summer, with a view to the technical working group preparing a paper for consideration by the Livestock Export Standards Advisory Group (LESAG).

c. AQIS to accept the exporter's decision to not prepare station sheep for export between May and October each year.

d. Industry to advise AQIS when the revised heat stress risk assessment software is available to better manage the risk of heat stress, particularly on open two tiered decks, for the 2010 Northern Hemisphere summer.

e. The livestock export industry to consider:

- progressing future research and development to investigate management strategies to reduce stress in the registered premises, particularly during inclement weather
- a program to enable the collection (and processing on return to Australia) of post-mortem samples on each voyage, in order to provide definitive information for a diagnosis in the event of a reportable mortality investigation or detection of an animal health issue.

8. Actions

AQIS placed the following condition on a subsequent consignment of sheep exported from Fremantle to the Persian Gulf by this exporter in October 2009:

- No sheep are to be shorn within 48 hours prior to departure from the registered premises.

9. Results

The result for the consignment with this additional condition was acceptable, with 462 mortalities reported out of 65,495 sheep loaded, equating to a mortality rate of 0.71%.

The subsequent two voyages on the same vessel, without the condition in section 8 in place, were also acceptable with sheep mortalities less than 1% for both voyages.

The exporter has regularly shipped similar consignments of sheep to the Persian Gulf. Since January 2007, this exporter has exported over 2.5 million sheep to the Persian Gulf on 55 voyages with an overall mortality rate of 0.92%.

10. References:

1. Maunsell Australia Pty Ltd. 2003. LIVE.116 Development of a heat stress risk management model. Meat and Livestock Australia.
2. Richards, R., R. Norris, et al. (1989). "Causes of death in sheep exported live by sea." Australian Veterinary Journal 66(2): 33-38.
3. Kelly, A. P. (1996). Mortalities in sheep transported by sea. Faculty of Veterinary Science. Melbourne, University of Melbourne. PhD.