
**INDEPENDENT REVIEW
OF CONDITIONS FOR
THE EXPORT OF SHEEP
TO THE MIDDLE EAST
DURING THE NORTHERN
HEMISPHERE SUMMER**

11 May 2018

The Hon. David Littleproud MP
Minister for Agriculture and Water Resources
Parliament House
Canberra ACT 2600

Dear Minister

On 10 April 2018 you announced that I would undertake an independent, short, sharp review to advise on conditions for the export of sheep to the Middle East during the northern hemisphere summer, in accordance with the review terms of reference on the Department of Agriculture and Water Resource's website. It was delivered on 11 May 2018.

The Australian Standards for the Export of Livestock (in their entirety) are being reviewed by a technical committee, which commenced in 2017 and is ongoing. This review is more targeted and applies only to the export of sheep to the Middle East in the northern hemisphere summer.

In conducting this review, I have consulted with key stakeholders and received much-appreciated assistance from officers of your department including Dr Mark Schipp, Australian Chief Veterinary Officer, and those who assisted as secretariat for the review.

I now enclose, for your attention, my report and recommendations.

Yours sincerely

A handwritten signature in black ink, appearing to read 'M McCarthy', with a large, stylized flourish at the end.

Dr Michael McCarthy

1. Executive Summary

The recent release of footage covering on-board treatment of sheep, over a series of voyages to the Middle East, last year shocked the Australian community, undermining public confidence in the trade. For the livestock export trade to continue, the public expects the Australian industry to uphold and comply with the highest animal welfare standards throughout the entire supply chain.

In response to the footage, the government commissioned this review to advise on conditions and any changes to the administration of the Australian Standards for the Export of Livestock (ASEL) and/or actions that would be required to assure the health and welfare outcomes for sheep being transported to the Middle East during the northern hemisphere summer.

Whilst it is acknowledged that the findings of this review may have implications for the trade and the farm gate price for Australian sheep, the terms of reference are clear, and refer specifically to what is required to assure the health and welfare of the sheep during the northern hemisphere summer period.

The review has been undertaken with a view to provide a roadmap for the way forward. It has not been undertaken with a view to being a blue-print for new legislation, nor is it meant, in any way, to replace or usurp the work being undertaken by the ASEL Review Technical Advisory Committee.

The review has considered the best evidence in the time available, including consideration of the scientific literature, recent live sheep export-related video footage, reports from observers on recent voyages and other relevant information.

The review's recommendations fall into two categories. There are those recommendations that should be implemented as soon as practical if the trade continues during the higher risk 2018 northern hemisphere summer. These recommendations address the immediate and specific challenges of exporting sheep from Australia to the Middle East during that period. These are interim measures to apply until October 2018. The review recognises that some other recommendations may require more time to implement and these will be considered by the ASEL review committee within their own time frame.

Overall, this review concludes that the live export industry is at the crossroads. What has occurred in the past must not happen in the future, and industry must therefore retreat to a 'safe' position, consolidate and then build a new way forward based on science, trust and performance.

The central issues relevant to sheep health and welfare during shipping to the Middle East in the months of May to October are stocking density, ventilation and thermoregulation in the sheep. The review makes a number of recommendations related to these factors. In summary the main recommendations are:

- that the industry moves away from using mortality as a measure to a focus on measures that reflect the welfare of the animal. Within the risk assessment model this replaces the mortality limit with a heat tolerance level
- that the risk settings on the Heat Stress Risk Assessment (HSRA) are to be adjusted to better reflect community expectations

- that space allocation should embrace 'allometric' principles and adopt a k-value of 0.033, and this be utilised for any periods within the May to October period, unless overridden by the HSRA model's assessment
- that a vessel's pen air turnover (PAT) be independently verified, as part of the condition of an approved arrangement for sheep travelling to the Middle East during the northern hemisphere summer
- that the reportable level for sheep travelling from Australia to the Middle East be reduced from 2% to 1% effective immediately
- further recommendations as described in the body of this review.

In terms of immediate action:

- the risk settings in the HSRA model can be changed reasonably quickly and should be operational for this northern hemisphere summer or at a minimum by 1 July 2018
- PAT verification will be more time consuming but is an essential condition of the approved arrangements going forward
- space allocation can be applied as soon as practical or at least by 1 July 2018
- a reduction in the reportable level.

Subsequent actions would include:

- modification of the HSRA model to include duration of exposure and the period of time that sheep are exposed to heat without respite
- the inclusion of ventilation design as a factor in the HSRA model
- modification of the way in which the model manages 'open decks'

and also include:

- a re-assessment of the recommended tolerance level and the probability risk settings.

The review makes a series of further recommendations and these are outlined in the body of the report.

It is anticipated that the new settings will impose substantial restrictions of many vessels wishing to participate in the trade during the northern hemisphere summer period, depending on the month, their ventilation capabilities, the cargo they intend to carry and the destinations involved.

This is an important moment in time. The live export industry, as a whole, covers a spectrum of activity. Strife in one sector impacts strongly on another. It is time for the industry to come together as a whole, and place a much stronger emphasis on animal welfare and move away from measures that use mortality as a benchmark. Reportable levels, voyage success and risk parameters have all been based around mortality. It is envisaged that the 'new world' will replace mortality with a raft of welfare measures and involve a quantum shift in attitude and behaviour.

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2. Introduction

This review has been conducted as an independent, short, sharp review to advise on conditions (as specified in approved arrangements) that would be required to assure the welfare of sheep travelling to the Middle East in the northern hemisphere summer if the trade were to continue. The review has worked systematically through the terms of reference within the short time frame provided. As a result, there may be aspects that have not been addressed and/or the need to refine what has been stated due to the nature of the review being so time-bound.

Any advice forwarded makes the assumption that the recommendations are properly implemented and that the regulatory framework surrounding the recommendations is effective.

Recent events have again heightened scrutiny, and the industry is very much at the crossroads. Very clearly, what has been the case in the past, will not be the case in the future and a new way forward is required. The current watershed is a great opportunity for the industry to take stock, embrace change and move forward with a new paradigm.

The live export industry, as a whole, covers a broad spectrum of activity. Strife in one sector impacts strongly on another. It is time for the industry to come together as a whole, and place a much greater focus on animal welfare and a move away from measures that use mortality as a benchmark. Reportable levels, voyage success and risk parameters have all been based around mortality. It is envisaged that the new world will replace mortality with a raft of welfare measures and involve a quantum shift in attitude and behaviour.

The review has been undertaken with a view to provide a road map for the way forward. It has not been undertaken with a view to being a blue-print for new legislation, nor is it meant in any way to replace or usurp the work being undertaken by the Australian Standards for the Export of Livestock (Version 2.3) (ASEL) Review Technical Advisory Committee. Wherever possible the findings of this review have been forwarded to the appropriate areas for further development and implementation. Foremost in this, of course, is the Minister for Agriculture and Water Resources.

The terms of reference are quite specific and refer to conditions within approved arrangements. The conditions in mind are those conditions that would allow trade to continue. In general, the recommendations are made based on the construct that the industry should retreat to a 'safe' position, consolidate and then build forward on the basis of science, trust and performance. The recommendations below reflect this approach.

3. Recommendations

Recommendation 1—Compliance

The Department of Agriculture and Water Resources (the department) must ensure that exporters, through their approved arrangements, comply with any legislative requirements, ASEL and any other conditions of their approved arrangements.

Recommendation 2—Stocking Densities

Based on the available science, and as an interim measure, sheep destined to the Middle East from Australia during the northern hemisphere summer should be allocated space allometrically using a k-value of 0.033 or such further space as required by the industry heat stress risk assessment model. Use of this allometric stocking density should be reviewed by the ASEL Review Technical Advisory Committee and/or an independent taskforce at the end of the forthcoming northern hemisphere summer.

Recommendation 3—Heat Stress Risk Assessment

Industry should move from a risk assessment based on mortality to a risk assessment based on animal welfare.

Recommendation 4—Heat Stress Risk Assessment

As an interim measure, it is recommended that the risk be set at a 2% probability of 5% percent of the sheep becoming affected by heat stress (Heat stress score 3—see Table 1). These settings should be reviewed by the ASEL Review Technical Advisory Committee at the end of this northern hemisphere summer period and again, annually by an independent taskforce.

Recommendation 5—Heat Stress Risk Assessment

That the required changes to the industry HSRA model be made immediately and then included in Version 5 of the HSRA model.

Recommendation 6—Heat Tolerance Level

As an interim measure, industry should adopt Table 1 (of this review)—‘An amalgamation of heat stress indicators’ to determine the acceptable heat tolerance level.

Recommendation 7—Heat Stress Risk Assessment

A future version of the industry HSRA model to be developed, adopted and used by industry during the northern hemisphere summer of 2019 should have the capacity to assess:

- a) the duration of time that sheep are exposed to high heat loads without respite
- b) ventilation design rather than assessing risk based on airflow alone

In addition, the way in which the model manages open decks should be reviewed.

Recommendation 8—Heat Stress Risk Assessment

A future version of the industry heat stress risk assessment model to be developed, adopted and used by industry during the northern hemisphere summer of 2019 should reassess:

- a) the 'heat tolerance' level
- b) the probability risk settings.

Recommendation 9—Pen Air Turnover

The report strongly supports the recommendation from the ASEL Review Technical Advisory Committee that a vessel's pen air turnover be independently audited before travelling to the Middle East in the 2018 northern hemisphere summer.

Recommendation 10—Register of vessels

A relevant government agency should maintain a register of vessels whose pen air turnover (PAT) information has been certified following auditing and verification.

Recommendation 11—Verification of PAT information

It would be a condition of an approved arrangement that all livestock vessel's PAT information has been independently verified where the vessel is destined for the Middle East during the northern hemisphere summer.

Recommendation 12—Curfew adjustments for stocking density

The weight of animals for the purposes of stocking density should specify curfew and adjustments should be made to reflect a 12-hour curfew (i.e. the livestock industry standard).

Recommendation 13—Compliant loading of animals

Authorised officers should check and verify the weights of sufficient animals to be satisfied that the vessel is to be or has been loaded in a way that is consistent with a compliant heat stress risk assessment and ASEL. This may be conducted at any point in the supply chain.

Recommendation 14—Use of sawdust

There is no need for sawdust for bedding under normal circumstances on sheep voyages but the use of sawdust strategically before and/or during the voyage should be included in an exporter's heat stress management plan, if required, for targeted areas on the vessel.

Recommendation 15—Purchase lines

Both the Australian Government Accredited Veterinarian (AAV) and the Independent Observer (IO) should be given information regarding the purchase lines of all sheep included in the consignment (i.e. the denominator) to identify 'line effects' within the mortality pattern on board. This can be encoded if confidentiality is an issue. Line effects identified over the course of the voyage should be investigated once the voyage has been completed.

Recommendation 16—Roles and responsibilities

With the advent of IOs, a taskforce should be established to determine the roles and responsibilities of AAVs, IOs and accredited stockmen. This responsibility may fall to the ASEL Review Technical Advisory Committee.

Recommendation 17—Animal carcasses

All livestock vessels traveling to the designated special zones in the Middle East during the northern hemisphere summer should be equipped with a serviceable hogger and/or a refrigerated container of suitable size to hold animal carcasses whilst in port (or at sea if required). This requirement should be included in an approved arrangement and AMSA should be notified of the requirement.

Recommendation 18—Reportable mortality level

The reportable mortality level for sheep exported by sea to the Middle East should be reduced from 2% to 1%.

Recommendation 19—Daily reporting

The use of both a panting score and a heat stress score should be a mandatory requirement in the daily report. A training module may be required to ensure that score allocation is consistent across industry.

Recommendation 20—Automated watering systems

All vessels carrying sheep to the Middle East during the northern hemisphere summer should have automated livestock watering systems.

Recommendation 21—Heat Stress Management Plan

A meaningful heat stress management plan could be a part of an exporter's approved arrangement. This plan should address the contingencies outlined in this review.

Recommendation 22—First port of unloading

Where Kuwait is one of the vessel's destination ports, this should be the vessel's first port of unloading.

Recommendation 23—Monitoring equipment

All vessels travelling to the Middle East during the 2019 northern hemisphere summer and after should have automated continuous environmental monitoring equipment installed as a condition of any approved arrangement.

4. Background

On 8 April 2018, the Nine Network aired footage provided by Animals Australia on the *60 Minutes* program showing conditions aboard a live export vessel containing sheep bound for the Middle East over five voyages.

The Department of Agriculture and Water Resources (the department) took immediate action to add an independent department veterinarian to an upcoming voyage to the Middle East as an observer, to monitor and record the health and welfare of the animals on board. The department also applied additional specific conditions for subsequent voyages including (but not limited to):

- reduced stocking density and improved ventilation
- adding an additional accredited stockman on top of the current practice of two accredited stockman
- requiring the first port of discharge to be Kuwait when travelling to multiple Middle Eastern ports, providing more space for remaining livestock heading towards higher humidity ports.

The Hon David Littleproud MP, Minister for Agriculture and Water Resources announced a range of initiatives designed to increase transparency and culture within the live export industry and its regulation. These initiatives included:

- a whistleblower hotline to enable confidential reporting of suspected breaches
- a review into the investigative capacity, powers and culture of the independent regulator for live exports, the department
- an announcement on 10 April 2018 of a short, sharp independent review into the export of sheep to the Middle East during the northern hemisphere summer.

The review was tasked to advise on conditions and any changes to the administration of the Australian Standards for the Export of Livestock (Version 2.3) (ASEL) and/or actions that would be required to assure the health and welfare outcomes for sheep being transported to the Middle East during the northern hemisphere summer. Specifically, the terms of reference were to:

- recommend any changes and/or additions to the conditions within approved arrangements that would be required to assure animal health and welfare if the trade were to continue. This would include, but not be limited to, conditions addressing:
 - stocking density (and if Heat Stress Risk Assessment model stocking density levels were maintained, what additional measures would be required to achieve health and welfare outcomes)
 - bedding and animal waste management
 - ventilation (including potential use of air-conditioning) and the assessment of heat stress risk
 - livestock systems for feed and water
 - the competency of crew, provision of stockmen and role of the AAV in managing animal health and welfare
 - morbidity and mortality management
 - contingency planning
 - reporting.

- evaluate and review the conditions (as specified in approved arrangements) that have been placed on voyages in previous northern hemisphere summers and more recently in the lead up to the 2018 northern hemisphere summer, and recommend any revisions
- identify any improvements in the administration of ASEL, including but not limited to:
 - the department’s interactions with AMSA for vessel approval
 - the effectiveness of current reporting requirements for vets and exporters (including other specific animal welfare outcome indicators)
 - additional assurance that approved arrangements are being met.

The live animal export industry is important for Australia being a significant economic contributor to both the national economy and regional Australia.

In addition there is a comprehensive review of the Australian Standards for the Export of Livestock (ASEL) by a panel of experts currently in progress that commenced in February 2018.

The industry has a chequered history. There are many tales of high mortality heat stress events incurred on voyages to the Middle East, particularly in the early open deck vessels. There are many sources of data for those wishing to plot mortality over time and/or analyse mortality patterns. They are not included in this review.

5. Purpose

To advise on conditions (as specified in approved arrangements), any changes to the administration of ASEL and/or actions that would be required to assure health and welfare outcomes for sheep being transported to the Middle East during the northern hemisphere summer.

6. Coverage

The review has considered the best evidence in the time available, including consideration of the scientific literature, recent live sheep export-related video footage, reports from observers on recent vessels and other relevant information.

6.1 Approved arrangements

Approved arrangements have good and bad points. Approved arrangements provide a great deal more flexibility and are cost effective in a world of full cost recovery. They are supported by legislation but require a greater degree of trust and accordingly there are more opportunities to exploit vulnerabilities in the regulatory framework.

It is the charter of this review to recommend any changes and/or additions to the conditions within approved arrangements that would be required to assure animal health and welfare *if the trade were to continue*. In essence, these arrangements are either on top of, or supporting of, the ASEL requirements. However, no amount

of additional conditions will provide any sort of fix if the fundamentals are not addressed.

It is an expectation, that if exporters conduct themselves in keeping with the ASEL standards, that animal welfare will be assured. A review of ASEL is underway, and this review, which underpins 'approved arrangements', is an important part of the overall ASEL review process.

6.1.1 Ventilation and the assessment of heat stress

Livestock vessels rely on mechanical ventilation. This ventilation has three tasks:

- One is to remove the heat and water vapor produced by the animal.
- Another is to lift moisture from the sheep manure pad.
- The final task is to remove any possible build-up of noxious gases.

These tasks can be quantified and framed as the work required for each cubic metre of air as it passes through the hold.

Ventilation is measured in a number of different ways and the design of ventilation systems varies. The traditional measure of ventilation has been exchanges per hour (eph). An eph of 60 indicates that the air within the hold is exchanged 60 times in an hour. It also indicates that it will be in the hold for one minute and has only one minute to undertake the tasks described above.

A further measure of ventilation is pen air turnover (PAT). This is measured as m³/hour per square metre of pen space. It is a measure of airflow. It does not, however, consider ventilation design and is only concerned with the amount of air flowing through the hold, not the way in which it is delivered.

The PAT does, however, link airflow to the pen area and therefore links airflow to the animals based on their stocking density. This is the central premise of the HSRA model. The model includes animal factors such as wool length, fatness, category, body weight and acclimatisation. These animal factors dictate the animal's heat stress tolerance. The model then assumes a distribution curve of tolerance within the mobs involved. Weather data for different times of the year is used to anticipate the likelihood of a heat stress event. A jetting factor is also applied that partly reflects the vessel's ventilation design. Risk is then calculated on the basis of a probability of a mortality rate.

Regardless of how the model has been operating, there is an argument to suggest that this setting should be reduced (either in terms of probability or in terms of the mortality) and, in keeping with a more welfare orientated focus, it has also been suggested that the mortality risk setting be replaced by a setting that reflects the likelihood of an animal experiencing heat stress. It is strongly recommended that both these suggestions be adopted going forward.

Some ventilation designs are better than others and the way in which airflow is delivered is equally as important as how much air is delivered. This is not directly implicit in the PAT measurement. A further measure, a minimum airspeed within the pen of 0.5m/sec is adopted by the Australian Maritime Safety Authority (AMSA). This measure reflects both the mixing of air (i.e. air distribution) and indirectly predicates a minimum airflow. It is, however, a minimum and does not have the capacity to link to the animal (and/or stocking density) and provide any sort of risk assessment.

Although it is embedded in the department's regulatory framework, and is a condition of ASEL, the industry HSRA model is owned by Meat and Livestock Australia (MLA)/LiveCorp with intellectual property considerations in regards to the model's author. Most of the workings of the model are explained in the series of industry specific final reports surrounding the subject.

The industry model is based on the principle of the wet bulb rise. This is the rise in wet bulb temperature that occurs between the time the air comes into the hold and the time it leaves and reflects the heat and water vapour added to the air in the course of cooling the animal. The higher the PAT the lower the wet bulb rise. Doubling the PAT halves the wet bulb rise. The anticipated rise is added to the ambient wet bulb temperature (the ambient challenge) and this is then compared to the animal's tolerance. If the wet bulb challenge exceeds the tolerance level, heat stress will eventually ensue.

It is vital, therefore, that the claimed PAT of a vessel is accurate, since this will dictate the extent of stocking density reduction that might be required to ensure that the heat tolerance levels are not exceeded. Halving the stocking density will halve the wet bulb rise and this may stop the overall challenge from exceeding critical levels.

Inherent in the model is the heat stress threshold. This is a contentious measure and there are several definitions in the literature. In the construct of the HSRA model it is the point at which animals go from shedding heat by passive means to utilising more active means to remove heat from their body (i.e. raising their respiratory rate and or sweating in the case of cattle). It is not the point at which animals are heat stressed. This will coincide with a slight rise in core body temperature as part of what is a normal and perfectly natural physiological response. This is the trigger to engage further heat loss mechanisms. Without the ability to 'buffer' heat in the form of heat load, animals would have to match their heat loss mechanisms to the heat challenge in a way that would be far too precise to meet their normal daily activities.

Disregarding, for now, the issue of duration of exposure, the question then becomes 'what level of exposure to heat should be deemed acceptable?'. Sheep, because they are so limited in the way in which they shed heat from their skin, have developed an extraordinary mechanism by which to shed heat from their body. Under challenge, sheep have the unusual ability to

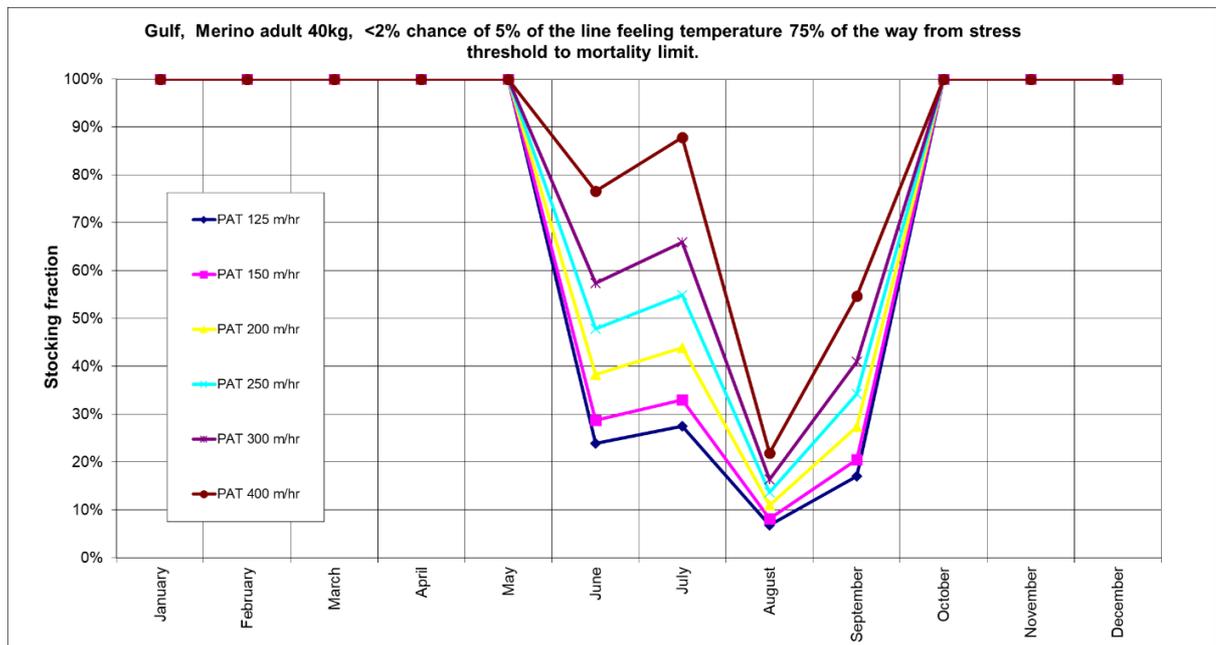
divert a large part of their normal blood flow to their nasal turbinates, and this, combined with an elevated respiratory rate is a highly effective heat loss mechanism. The extent to which they can divert blood flow is quite staggering. Sheep can divert up to 30% of their blood flow through their turbinates and upper respiratory tract (Hales, 1967) in order to shed heat. Given this extraordinary adaptation, an elevated respiratory rate should not be seen in the same way as it would for say, a human or even cattle.

There is a point, however, above which the welfare of the sheep is compromised and the Table 1 provides a basis upon which to make this assessment. This has been adapted from earlier tables. A heat stress score of 5 has been removed since this is the point at which an animal is essentially moribund. A heat stress score of 3 depicts the onset of heat stress.

Without going into detail, the experimental work undertaken at Murdoch University (Stockman, 2007 and Barnes et al 2011) provides additional physiology to the above scores in terms of shifts in core body temperature, electrolyte balance (respiratory alkalosis) and other parameters.

In keeping with a focus on welfare, this becomes the new tolerance limit within the industry HSRA model. The risk setting then becomes a 2% probability that 5% of the sheep will become heat stressed (heat stress score 3). This aligns with the allowable stocking fraction with the animal criterion backed away by 25% (from mortality limit toward the heat stress threshold). It is recommended that this risk setting be incorporated into the new version of the industry HSRA model (version 5) and that this be utilised on all voyages carrying sheep to the Middle East during of the forthcoming northern hemisphere summer.

Figure 1: The allowable stocking fraction with the animal criterion backed away from mortality limit 25% of the way to the heat stress threshold.



Source: Work commissioned by MLA/LiveCorp 'Effect of livestock heat stress risk standard on stocking densities for sheep on live export vessels'

Duration of exposure is an important dynamic in the development of heat stress. Without respite, sheep will take on heat load, and if this becomes excessive they may succumb to heat stress. On this basis, sustained exposure to heat may become just as intolerable as a short burst of severe heat stress, and this is important when the risk is being simply compared to a wet bulb temperature. The industry HSRA model does not factor the duration of exposure in its current form. It is recommended that duration of exposure be included in the HSRA model in any future version, and that this version be available for the 2019 northern hemisphere summer.

The mechanical ventilation system used on livestock vessels works on very high air turnovers. Air conditioning has been contemplated on many an occasion but it requires a low air turnover, and often the recycling of air to be effective (and/or cost effective). With the current available technology, this is not an option on livestock vessels. High turnovers are required to remove gases and lift moisture from the pad.

As mentioned previously, the HSRA model does not currently include a robust measure that relates to ventilation design (or the way in which air is delivered into the hold). The jetting column within the model could be used to factor ventilation design and it is recommended that this be included in a further upgrade of the HSRA model be undertaken and be made available for the 2019 northern hemisphere summer.

Best Resource(s):

Barnes, A, Beatty, D, Taylor, E, Stockman, C, Maloney, S, McCarthy, M (2004) Physiology of Heat Stress in Cattle and Sheep (LIVE.209). Prepared by Murdoch University for MLA/Livecorp.

MAMIC Pty Ltd (2000) Investigation of Ventilation Efficacy on Livestock Vessels—Final Report (SBMR.002A). Prepared for MLA/Livecorp.

MAMIC/Maunsell Pty Ltd (2003) Development of a Heat Stress Risk Assessment Model (LIVE.116). Prepared for MLA/Livecorp.

Further reading:

..... refer to list of references in the appendices.

Table 1. An amalgamation of heat stress indicators

| Heat Stress Score | Panting Score | Respiratory Rate (RR) | Respiratory Character | Appearance or demeanour | Extrapolated percentage of ML within the HSRA model |
|-----------------------------|--------------------------------------|-----------------------|-----------------------|-------------------------|---|
| 0—Normal | 0—Normal | 25–80 | Normal | Normal | 0 |
| 1—Elevated respiratory rate | 1—Normal (elevated RR) | 80–100 | Increased RR | Normal | 0–35 |
| 2—Heat affected | 2—Mild panting | 100–160 | Rapid RR | Discomfort | 36–75 |
| 3—Onset of heat stress | 3—Open mouth panting | 160–220 | Laboured | Extreme discomfort | 76–85 |
| 4—Severe heat stress | 4—Open mouth panting with tongue out | Usually second stage | Extremely laboured | Distressed | 86–100 |

**N.B. This table has been extracted from a number of sources.*

It is agreed by all parties that the industry must move from a risk assessment based on mortality to a risk assessment based on animal welfare. It is recommended that the industry HSRA model accommodate this by a move from the mortality limit (ML) to a heat tolerance level and adopt the above table to determine the acceptable tolerance level.

It is recommended that the model adopt the view that subjecting sheep to a heat stress score of 3 (as described in the table above) is unacceptable. There is no industry specific research that directly correlates this tolerance level to a percentage of the mortality limit utilized by the HSRA model and most of the shore based experimental work factored the duration of exposure and heat load. Based on extrapolation, and to assure the welfare of the sheep, an assumption of 75% of the difference between the heat stress threshold (HST) and the mortality limit (ML) would appear to be the best fit. A lower level of assurance could be considered but this would require validation. Note that the relationship between heat stress score and wet bulb temperature (as a percentage of the ML within the model) may not be linear.

The HST as defined within the construct of the model is the point at which animals move from dissipating heat via passive means to needing to use more active methods such as panting. It is used to benchmark animals across all categories within the model. As an interim measure, it is recommended that the existing settings of a 2% probability of 5% remain the same but that the mortality limit be replaced by a tolerance limit that corresponds to a heat stress score of 3 (as stated above). These settings, however, should be reviewed annually by a suitably appointed independent task force (or ASEL review technical consultative committee in the interim). It should be noted that this does not infer that it is acceptable for 5% of the sheep to be severely affected, but reflects that there is a very low probability of it happening.

It is anticipated that this new setting will impose significant restrictions on many vessels wishing to participate in the trade during the northern hemisphere summer period, depending on the month, their ventilation capabilities, the cargo they intend carrying and the destinations involved. Verification of the vessel's PAT information.

6.1.2 Verification of a vessel's PAT information

An independent, one-off audit of a vessel's PAT information prior to travelling to the Middle East in the northern hemisphere summer, is a strong recommendation from the ASEL Review Technical Advisory Committee. Furthermore, it is recommended that a relevant government agency keep a record of which vessels have been validated. AMSA may be the most logical agency since AMSA is responsible for the vessel's provision of services of which ventilation is probably the most important.

When contemplating a vessel charter, the fact that the vessel's PAT information has been independently verified would be a condition within an approved arrangement going forward.

Best resources:

MAMIC, PL (2002) Practical Ventilation Measures for Livestock Vessels. MLA and Livecorp No. ISBN: 1 74036 118 0, Sydney, NSW, Australia.

MAMIC Pty Ltd (2000) Investigation of Ventilation Efficacy on Livestock Vessels—Final Report (SBMR.002A). Prepared for MLA/Livecorp.

Further reading:

..... refer to list of references in the appendices.

6.1.3 Stocking density

As mentioned, stocking density is **the** key parameter when shipping livestock in the northern hemisphere summer. There are two densities involved. The first is that adopted before the HSRA model imposes any further restrictions, and the second is the density dictated by the HSRA model.

It is recommended that an 'allometric' approach be adopted by the industry for the forthcoming northern hemisphere summer with a k-value of 0.033. This is the "*threshold below which there are consistent adverse effects on welfare outcomes in intensive housing*". These terms have been extracted from the paper by Petherick and Philips (Petherick and Philips, 2009) entitled "Space allowances for confined livestock and their determination from 'allometric' principles". The review found no science to refute this allocation of space. A lesser k-value of 0.027 provides sufficient space for animals to stand and lie down but does not, according to the authors, allow free access to troughs and assure "*no adverse effects on welfare outcomes in intensive housing*". There is a small case to suggest that the shipping of sheep to the Middle East is actually transport rather than housing, however

this might only apply on voyages that are much shorter in duration than those to the Middle East.

In the absence of any refuting science, and as an interim measure, a k-value of 0.033 would appear the best fit if the welfare of the sheep is to be assured. A lower level of assurance could be contemplated but it is not backed by science at this point in time.

The density dictated by the HSRA model throughout the northern hemisphere summer has been outlined earlier. Both these densities should be reviewed by a suitably selected task force before the next northern hemisphere summer.

Stocking density is more than heads of livestock. It relates to both heads of livestock and weight. The current ASEL does not specify whether weight refers to an empty body weight, a curfew weight (12 hour curfew) or a full weight. There can be up to a 12% difference in these weights. This obviously has a large bearing on the effective stocking density once the animals are in the pens. It is suggested that the ASEL Review Technical Advisory Committee address this anomaly. Verification of weights should be a part any future approved arrangement, whether as overall weight or as 'spot checks' based on the principle of what the industry terms 'pencil shrink' (i.e. adjusted for curfew).

Space allocation for an animal is described in terms of area measured in square metres (m²). The body weight of an animal can be used to calculate the volume of an animal. Petherick 2007 and Petherick and Phillips 2009 indicate a formula for determining the space allocation for an animal as:

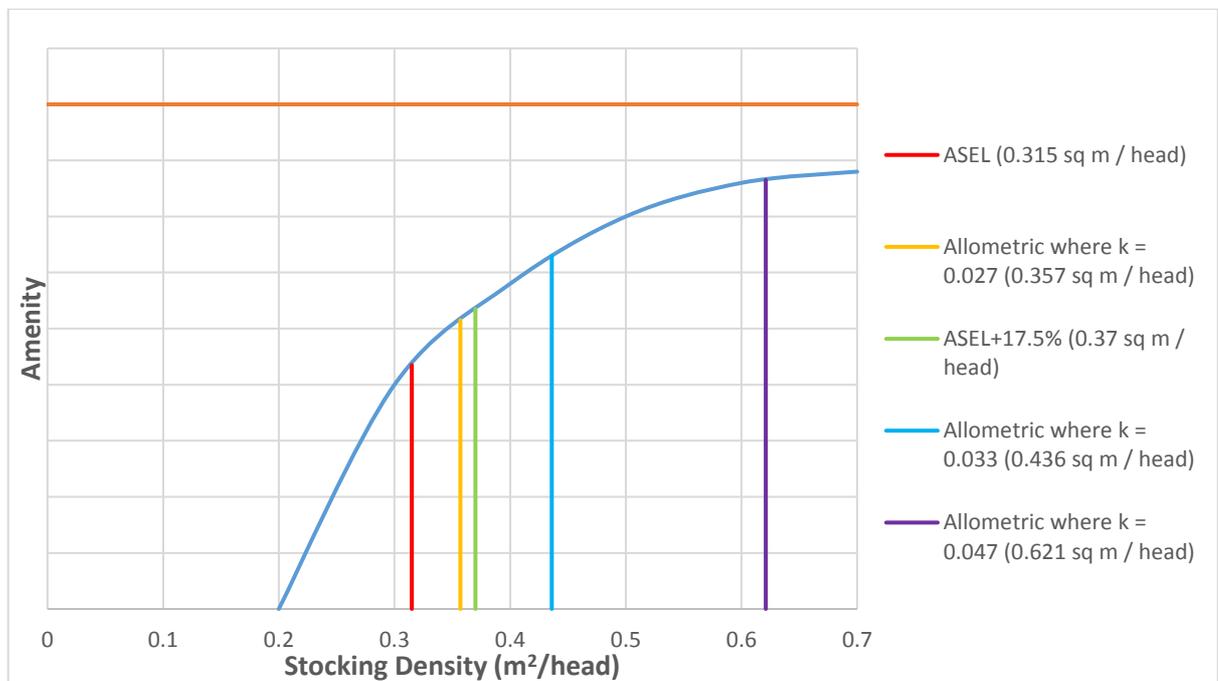
$$A = kW^{0.66} \text{ where } A \text{ is area in m}^2; k \text{ is a constant and } W \text{ is the weight of the animal (Source: Petherick 2007 and Petherick and Phillips 2009)}$$

The review recommends that space allocation per sheep for sheep exports during the northern hemisphere summer be based on allometric principles based on a k-value of 0.033, or as much space as is required by the industry HSRA model. This increase in space will assure the health and welfare for sheep being transported to the Middle East during the northern hemisphere summer.

Table 2. A comparison of minimum ASEL area (May to October) to an allometric space allocation based on $k = 0.033$

| Liveweight (kg) | Minimum pen area (m ²) May–Oct | Allometric Allocation $k = 0.033$ | Percentage Change Allometric v ASEL May–Oct |
|-----------------|--|-----------------------------------|---|
| 30 | 0.265 | 0.311 | 18% |
| 35 | 0.278 | 0.345 | 24% |
| 40 | 0.290 | 0.377 | 30% |
| 45 | 0.303 | 0.407 | 34% |
| 50 | 0.315 | 0.436 | 39% |
| 55 | 0.351 | 0.465 | 32% |
| 60 | 0.381 | 0.492 | 29% |
| 65 | 0.423 | 0.519 | 23% |
| 70 | 0.468 | 0.545 | 16% |
| 75 | 0.515 | 0.570 | 11% |

Figure 2. Representation of amenity afforded by additional space



In general, terms, stocking density can be thought about in terms of amenity. At current ASEL densities, the provision of say 10% more space adds considerable amenity. However, the additional of further space adds disproportionately less amenity until the point where additional space adds little extra amenity. This is simply a law of diminishing returns. At the other end of the scale, a 10% increase in stocking density (over and above ASEL) could actually become life threatening to the weaker sheep in the pen. Figure 2 depicts the general principle involved using space allocation for a 50kg sheep.

Best resources:

Petherick, JC (2007) Spatial requirements of animals: Allometry and beyond. *Journal of Veterinary Behavior* **2**, 197–204.

Petherick, JC, Phillips, CJC (2009) Space allowances for confined livestock and their determination from allometric principles. *Applied Animal Behaviour Science* **117**, 1–12.

Ferguson, D, Lea, J (2013) Refining stocking densities (W.LIV.0253). Prepared by CSIRO Animal, Food & Health Sciences for MLA/LiveCorp.

Further reading:

..... refer to list of references in the appendices.

6.1.4 Bedding (pad) management

For the most part, the sheep pad makes for excellent bedding. There is no need for additional sawdust or any other bedding additive under normal circumstances. There has been, however, some good work within the cattle export trade whereby the cattle pad is being extended (in terms of time) to enable voyages to China to be completed without undertaking a wash down. On these voyages, depending on the stocking density, bedding conditions can remain very dry and this is a sound management strategy (best practice) particularly when conditions at the destination are cold.

The key to this strategy is either to put down abundant sawdust at the commencement of the voyage, or add sawdust on a strategic basis to areas that need it as the voyage progresses. This same strategy may have a place in the sheep trade where some pad areas are known to deteriorate. Sawdust could be spread in these areas, either at the voyage outset, or strategically as the voyage progresses. It is not suggested that sawdust be used on a routine basis for the entire cargo. This could be part of an exporter's heat stress management plan but is unlikely to be a condition within an approved arrangement.

Best resources:

McCarthy, MR, Banhazi, T (2016) Bedding management and air quality on livestock vessels – A literature review (W.LIV.0290). Prepared by Global Livestock Solutions Pty Ltd for MLA/LiveCorp.

Further reading:

..... refer to list of references in the appendices.

6.1.5 The role of the Australian Government Accredited Veterinarian and the observer

From an industry point of view, an IO is an important part of regaining the trust of the general public, the regulators and any other interested parties.

It is strongly recommended that an IO, reporting directly to the regulator, be appointed for all voyages carrying sheep to the Middle East during the forthcoming northern hemisphere summer.

The caveat on this, is that the reporting and feedback of the IO must be actively received by someone who knows something about live exporting

and converts the information into something constructive, and/or takes action about any observed discrepancies (e.g. wool length).

Freed of the reporting responsibility, the AAV would act far more in the interests of the exporter, ship and the voyage outcome generally. There is no question that a competent veterinarian, supported by a competent stockman (or the other way around) are able to work with ship's crew on a regular basis to improve the overall management of livestock on the vessel.

Central to this debate is the question of what qualifications, training, knowledge and skills might be required to enable both the veterinarian and the observer to do their jobs. Further to that, what tools might they require, and further to that, what information do they need to do their respective jobs. For example, in regards to the northern hemisphere summer, and in recognition of the importance of ventilation during this period, the AAV and the observer should be expected to be familiar with the principles inherent in the heat stress risk assessment model and be provided with tools that allow him/her to measure key aspects of ventilation. This might include:

- a hand-held CO₂ monitor that allows the veterinarian to detect and map less ventilated areas
- hand-held temperature and humidity readers can confirm the wet bulb rise in specific areas of the ship
- data loggers that provide a continuous measurement of wet bulb temperature
- an anemometer to measure air speed together with a suitable tape measure to measure vent areas is also useful.

These skills are not meant to take the place of an engineer, but the ability to undertake certain basic tasks assists greatly in the overall understanding of the onboard environment.

The AAV and the observer should also be given the information they need to do the job. This might include a ventilation plan that designates PAT to each deck and/or hold, a copy of the HSRA printout and the weights for each line of sheep.

They should take an active interest in continuing education and be familiar with the key industry specific research that is relevant to that particular time of year.

The IO should be prepared for his/her task in a very similar way. There are complexities involved in defining these roles and it was not possible to tease these out in the short time frame that is made available for this review. It is suggested, therefore, that a small taskforce be formed, representing the various stakeholders, to better determine, describe and integrate the anticipated roles, responsibilities and activities for each of the respective parties (AAV, IO and possibly stockman). It is likely that this will evolve over time.

Best resources:

Brightling, T, Chapman, C, Reeves, P (2004) Livestock exports – Best practice use of veterinary drugs. Prepared for MLA/Livecorp.

Further reading:

..... refer to list of references in the appendices.

6.1.6 Provision of Australian stockmen

Good things can be achieved with the combination of a good accredited stockman and AAV that have the ability to engage with the crew and ship management. The number of stockmen then becomes a peripheral issue and relates more to other facets such as scabby mouth disease or other manning issues. Focussing on the important things that eliminate (or reduce the likelihood to a miniscule level) the chance of the crisis developing in the first place is far less reactive.

6.1.7 Mortality management

Mortality, is unfortunately a reality in the livestock production system. The onboard management of mortality is important to both the health and welfare of the animals as well as the crew.

On most vessels, the crew will conduct a mortality 'round' once or twice a day. Twice a day is recommended since this results in a much tidier vessel and allows earlier detection of moribund sheep (should they be present). Dead or moribund sheep will be removed from the pens and placed in an area that is suitable to conduct post mortems. Moribund sheep are euthanised.

Sick or injured sheep will also be removed during this inspection process and moved to a hospital pen. Care should be taken at all times to ensure that the process of removing sheep does not unwittingly cause harm to those sheep remaining in the pen.

Having conducted post mortems on those sheep that are suitable, the bodies are then removed. The International Convention for the Prevention of Pollution from Ships (MARPOL) has clear instructions about the disposal of dead animals—this direction appears in several places in export regulations.

In this regard, the Persian Gulf is a special case. The Persian Gulf has been designated a special zone. In this case, any bodies must either remain on the ship, or be put through a hogger. Leaving bodies on the ship (for the duration of the final part of the voyage) is macabre and a serious threat to human health. It is not an option. All ships travelling to the Persian Gulf ports should be fitted with a serviceable hogger. In addition to this, where the use of a hogger is not permitted, a refrigerated container should be available to hold bodies for as long as required. This should be mandatory. It is imperative that the direction in this regard is clarified by the authorities. The requirement for the hogger and the refrigerated container should be

included in the approved arrangements for all voyages travelling to the Middle East during the northern hemisphere summer. AMSA should be made aware that this has been made a condition within any approved arrangement.

It is normal practice to collect the ear tag information of all mortalities to contribute to the understanding of line effects and/or correlate with cause of mortality (see later). A cause of mortality distribution should be determined that relates both the actual post mortems undertaken (with or without diagnoses) as well as an estimated distribution based on the total number. In the 'new world' industry should expect a low mortality on an average sized vessel per voyage (and be taking steps to actively reduce this over time).

The use of electronic identification of sheep in sheep has been suggested and this has merit. The collation of information is challenging, but there may be many points at which electronic identification may be beneficial.

Best resources:

MARPOL Annex V (Regulations for the prevention of pollution by garbage from ships)

6.1.8 Reportable level

The current reportable level for sheep is a mortality of 2%. Notwithstanding that mortality may not be the measure of the future, a 2% mortality on a voyage that involves 70,000 sheep is 1,400 sheep. Events are long past the point whereby the industry (exporters) could expect the Australian public to consider this to be acceptable. Even 1% (i.e. 700 sheep) seems high. It is therefore recommended that the reportable level be reduced to 1% immediately and be maintained at 1% throughout the forthcoming northern hemisphere summer period. This may not have a big impact on the number of reportable voyages since the vast majority of voyages are below this level, but it provides a strong signal that the industry is serious about making improvements.

Most of the answers, in regards to minimising mortality are known. Industry has conducted a large body of 'industry specific research' that addresses most of the industry problems. Reducing the reportable mortality level raises the value of this research and places a greater imperative on adopting and implementing the findings.

A reduced reportable level could require more resources if existing investigation procedures are maintained and behaviour remains unaltered. The most likely scenario, however, is that behavior would be modified and the number of reportable incidents would remain unchanged or more likely fall.

Best resources:

Norman, GJ (2017) National livestock export industry sheep, cattle and goat transport performance report 2016 (W.LIV.0291). Prepared by: Department of Agriculture and Food, Western Australia for MLA (MLA/LiveCorp).

Norris, RT, Norman, GJ (2003) Mortality and morbidity risk factors for livestock during sea transport from Australia (LIVE.216). Prepared by the Department of Agriculture, Western Australia for MLA/LiveCorp.

6.1.9 Reporting

It is highly likely that the existing reporting procedures will be overhauled, particularly if the industry moves to having IOs report directly to the regulator. It is envisaged that the AAV will continue to report directly to the exporter. Information that is required by the regulator (e.g. post mortem and treatment details) will be shared with the IO.

In general, the existing reporting system is probably outdated and new technology is available that may revolutionise the reporting process, particularly with the advent of automated environmental monitoring. Digital data capture using a hand held device has been trialed within the industry and has shown promise.

Automated, continuous monitoring of temperature and humidity, sent to the bridge with the assistance of Wi-Fi technology, will allow real time measurement that has the potential to create alerts and provide clear graphical representation of conditions over the previous 24 hours (or more). This combined with improved weather forecasting services makes available possibilities that have never before been contemplated.

It is, therefore, folly to try to be too prescriptive about reporting at this point. The whole landscape should be mapped out and studied by those with knowledge of the equipment required and the information technology involved. This could be commissioned as an industry funded project.

Best resources:

McCarthy, MR, Banhazi, T (2016) Bedding management and air quality on livestock vessels – A literature review (W.LIV.0290). Prepared by Global Livestock Solutions Pty Ltd for MLA/LiveCorp.

Further reading:

..... refer to list of references in the appendices.

6.1.10 Panting score

The development of a better panting score for sheep is an industry priority. This has been discussed under an earlier heading. When combined with a heat stress score, a panting score is a powerful measure that provides strong validation and feedback information to both the HSRA model as well as to all the stakeholders involved in an individual voyage. Automated,

continuous monitoring of both temperature and humidity completes the picture. A panting score characterises the panting and considers more than just respiratory rate. This must be a robust measure since, in the 'new world', it becomes the measure against which outcomes are judged.

The use of both a panting score and a heat stress score should be mandatory in the reporting process. This may need a small taskforce, funded by industry, to ensure that the allocation of scores is consistent across the industry.

Best resources:

McCarthy, MR (2003) Pilot Monitoring of Shipboard Environmental Conditions and Animal Performance (LIVE.223). Prepared by Professional Agricultural Services Pty Ltd for MLA/Livestock.

Barnes, A, Beatty, D, Taylor, E, Stockman, C, Maloney, S, McCarthy, M (2004) Physiology of Heat Stress in Cattle and Sheep (LIVE.209). Prepared by Murdoch University for MLA/Livecorp.

Further reading:

..... refer to list of references in the appendices.

6.1.11 Animal welfare indicators

The use of animal welfare indicators is a recent initiative associated with an MLA-funded research program. It has been strongly endorsed by the Australian Livestock Exporters' Council (ALEC), who wish to use it as a tool to better animal welfare.

The welfare indicator project has made a tentative start and not made any outlandish promises in terms of delivery. It will take some time to find the key drivers that deliver simple indicators of welfare and/or contribute to the overall management of the sheep on the vessel. The welfare project has a great deal to offer, but it is yet to be seen as to whether the indicators involved will contribute to the IO role specified by the regulator or vice versa. It is unlikely that the welfare indicators will have any involvement in the regulatory framework at this point of time.

Best resources:

Collins, T (2018) 'Qualitative Behavioural Assessment: a novel tool for welfare evaluation, Proceedings of the ACV Annual Conference' Fremantle, Australia.

Wickham, Fleming, Collins (2017) 'Development and assessment of Livestock Welfare Indicators Survey' (Project code W.LIV.3032) (MLA)

Further reading:

..... refer to list of references in the appendices.

6.1.12 Wool length

Wool length is an important, and often overlooked aspect of shipping sheep to the Middle East in the northern hemisphere summer. It is an important input into the HSRA model and affects the model's calculation. It is strongly recommended that the wool length categories are re-visited in any revisions of the HSRA model.

Careful attention to wool length should therefore be part of the conditions of an approved arrangement. 'Off shears' sheep are far more heat tolerant and insisting that all sheep be 'off shears' could be a condition of an approved arrangement in special cases. Otherwise it would be left to the HSRA model to factor wool length along with all the other animal factors.

Best resources:

MAMIC/Maunsell Pty Ltd (2003) Development of a Heat Stress Risk Assessment Model (LIVE.116). Prepared for MLA/Livecorp.

Further reading:

..... refer to list of references in the appendices.

6.1.13 Livestock vessel systems for feed and water

The provision of feed and water come under the oversight of AMSA. This is dealt with under the provision of livestock services. There is some debate about the relative merits of automatic versus manual feeding. Both manual and automatic feeding can be managed so that feeding can be ad lib. Care must be taken, when feeding ad lib, to ensure that fines (powdered fodder pellets) do not accumulate in the feed troughs.

Water is slightly different. Whereas manual watering is often used on cattle voyages to South East Asia, there is no doubt that automatic watering removes one level of risk when transporting sheep to the Middle East during the northern hemisphere summer. This issue has been somewhat resolved since all the vessels travelling to the Middle East with sheep are now equipped with automatic watering systems.

6.1.14 Competency of the crew

The Awassi Express heat stress incident has brought into question the competency of the crew. Without being present, it is difficult to comment, however, this would seem to be a distorted view of what is more likely to be a situation where the crew were asked to perform well above their call of duty over a sustained period of time. This tests morale and the management capabilities.

Competency, however, should be a given. The tasks for most stockmen (crew) are not complicated and most work under the direction of a boson or Tindall. Ships vary in regards to how well they are managed and the relationship between the Captain, Chief Officer and Boson is key. It is not

recommended that any formal competency evaluation be required at this point of time.

6.1.15 Heat stress management (morbidity) and contingency planning

Heat stress (if and when it occurs) is difficult to contend with since there are only a limited number of things that can be done. There is a sense of powerlessness as the situation becomes overwhelmed by factors that cannot be controlled (at that point). The secret is to do as much as can be physically done to prepare for a heat stress event (again, should it occur). These include subtle adjustments in stocking density, removal of anything that obstructs airflow in and around the decks, checking the fans (on the cover deck) to ensure they are working at full capacity, ensuring all gratings (that are used as exhaust outlets) are free of obstruction.

Measures to address heat stress should be included in a heat stress management plan. This could consider adjustment in feeding (and this is commonplace in feedlots on land) where feedstuffs with a low heat increment can be fed (chaff on livestock vessels). Access to water is obviously essential and it is important not to disturb the animals lest they stop panting to deal with higher order priorities. These are the one percenters that make a difference, but clearly, the aim is to not be placed in this situation in the first place. It is recommended that all exporters present a meaningful heat stress management plan a part of their approved arrangements.

The heat stress management plan should address the following contingencies:

- being held at anchor awaiting clearance to go alongside
- adverse weather conditions that hold the vessel at anchor (e.g. strong cross winds across channels or fog)
- rough weather that stops the pilot from arriving
- unforeseen reasons that hold the vessel alongside prior to unloading
- radiant heat sources that are not factored into the HSRA model
- prolonged exposure to hot conditions that are not factored into the HSRA model
- inability to zig zag to maintain airflow across open decks due restrictions within sea channels (i.e. through the Babel Mandeb and the Straits of Hormuz). This can also occur in heavy shipping zones in anchorage zones and on entering port.

Best resources:

Barnes, A, Beatty, D, Taylor, E, Stockman, C, Maloney, S, McCarthy, M (2004) Physiology of Heat Stress in Cattle and Sheep (LIVE.209). Prepared by Murdoch University for MLA/Livecorp.

Further reading:

..... refer to list of references in the appendices.

6.1.16 First port and port unloading sequence

The notion of first port and unloading sequence has been discussed, off and on, for some time (at least 15 years). It first became an issue when vessels would regularly call into Muscat on their way to the Gulf ports and unload a small number (usually around 5,000) of heavy shipping wethers. Since Muscat is notorious for its fickle (and very hot and humid) weather, going alongside in Muscat could push an entire shipment of sheep beyond their heat tolerance levels, and this would occur regularly. The alternative strategy is to sail direct to Kuwait and partly unload the vessel there (where conditions are usually hot but dry) and then negotiate the vessel back through other Gulf ports and finally unload the Muscat wethers last. Whilst this would involve taking a full shipment through the Straits of Hormuz, it is a marginally less risky strategy and was, it seemed, mandatory at various points of time.

Nevertheless, if Kuwait is a destination port it should be mandatory for the vessel to sail directly to Kuwait and then negotiate the other Gulf ports with fewer sheep on board.

6.1.17 The effect of winter challenges in Australia and property of origin

The later part of the northern hemisphere summer coincides with the later part of the southern winter. This is characterised by wet, sometimes saturated conditions and a much higher risk of diseases such as Salmonellosis. The nutritional plane of sheep can be at its lowest coming out of winter, pending the spring flush of the season when sheep will often be at their strongest.

Acclimatisation also plays a part, and since there is a lag in the way in which sheep adjust their metabolic rate in response to the local weather, these sheep will be the least acclimatised with the greatest difference local temperature differences between where they come from and where they are going to.

The industry has completed a strong body of research that outlines how to address Salmonellae, including prospects for a vaccine. There is scope to improve the adoption of research findings.

Salmonellosis, when it occurs, is usually found in select lines of sheep and although these lines will inevitably be mixed into the consignment as a whole, the overall prevalence is generally low (although the severity of the disease results in a high mortality within these lines). Research has shown that careful attention to the sourcing of sheep during the late winter period has a profound effect on mortality rates and this could be fashioned into a condition within the approved arrangement. Sourcing sheep from sale yards, utilising traders to depot sheep and sourcing sheep from pastoral areas during the late winter period, have all been shown to contribute strongly to mortality levels.

This applies equally when addressing inanition. The research would indicate that there is a strong link between a subclinical Salmonellae and inanition but there is also evidence that it can have a link to metabolic factors (i.e. the homeorhetic switch being the orchestrated or coordinated control of metabolism needed to support a physiological state). Inanition is a feature of older, heavier and generally fatter merino wethers. It is not suggested that these be excluded from consignments at this point of time, since the risk assessment model will address many aspects in this regard, but consignments that include a significant number of this category of sheep should attract additional scrutiny.

Best resources:

Makin, K, House, J, Perkins, N, Curran, G (2010) Investigating mortality in sheep and lambs exported through Adelaide and Portland (B.LIVE.0123). Prepared by the University of Sydney for MLA/LiveCorp.

Further reading:

..... refer to list of references in the appendices.

6.1.18 Improved environmental monitoring

The current environmental monitoring on board livestock vessels is conducted manually, once a day, using either a whirling hygrometer or by reading wet and dry bulb thermometers at strategic sites around the ship. Better methods are available and have been suggested to the industry. Automated measurement of both temperature and humidity, with real time measurements being relayed directly to the bridge would seem to be a sensible (and indeed minimum) requirement.

A more robust method of measuring temperature and humidity is essential to any validation processes relating to either the HRSA model or the industry welfare indicators. The time frame is such that it is unlikely automated monitoring could be installed on vessels for this northern hemisphere summer. A requirement that all vessels travelling to the Middle East during the northern hemisphere summer have automated continuous environmental monitoring equipment installed, could be a condition within approved arrangements in any subsequent summer.

Best resources:

Gray, J, Banhazi, TM, Kist, A C Saunders, T Banhazi (Eds) (2013) 'Review of wireless communication technologies for environmental monitoring in livestock buildings, SEAg 2013.' Perth, Australia. (EA).

McCarthy, MR (2003) Pilot Monitoring of Shipboard Environmental Conditions and Animal Performance (LIVE.223). Prepared by Professional Agricultural Services Pty Ltd for MLA/Livestock.

Further reading:

..... refer to list of references in the appendices.

6.1.19 Training

In general, there is a need to better understand the workings of the heat stress model both in principle and in practice and training aids would assist in this process (particularly in the use of both panting and heat stress scores). Since these training aids would require both resources and time, it is unlikely that they would be of much assistance during this northern hemisphere summer. It is strongly recommended, however, that work on these is commenced with a view to having a full suite in place by the 2019 northern hemisphere summer.

Best resources:

LiveCorp—The Australian Livestock Export Corporation (2016) Shipboard Stockie's Guide 2016. Prepared by the Harris Park Group for LiveCorp.

6.1.20 Other considerations

There are a number of further considerations under this heading. These tend to be ship (or supply chain) specific rather than generic and include such things as using the stowage of excess fodder to provide insulation on the cover deck where radiant heat can be a factor. It may include stowing bos indicus cattle on the port side pens that are exposed to radiant heat on open decks. It may include the use of wetting on the cover deck to harness the latent heat of evaporation and cool the uppermost decks. These are the one percenters that can make big differences provided that the fundamentals have been properly applied. These initiatives might be listed in the heat stress management plan included as part of an approved arrangement. They are not likely to be part of any formal orders.

6.1.21 Conditions in the receiving country

This is outside the terms of reference of the review. It is however, very important and carries equal weight to any considerations in regards to shipboard conditions and conditions at the feedlots in destination countries may not necessarily reflect weather data collected for the destination ports.

Infrastructure 'in country' has improved and there is better access to shade and better attempts to cool animals during and after arrival. There have been MLA funded studies into these conditions (some with reports pending) but they have not been included in this review.

One of the big hazards in regards to the conditions in the receiving country is the overloading of feedlot facilities in destination countries in response to supply restrictions. Again, this is outside the scope of this review, but it is a real consideration and begs input from those with knowledge and experience in the region.

Whilst there is opportunity for the Livestock Global Assurance Program to foster and facilitate an international approach to animal welfare in the future, the reality of the immediate must be considered.

Best resources:

<https://www.mla.com.au/research-and-development/search-rd-reports/final-report-details/Determining-Temperature-and-Humidity-Thresholds-in-sheep-exported-from-Australia-to-the-Middle-East/3575>
.....No pdf available

<https://www.mla.com.au/research-and-development/search-rd-reports/final-report-details/Live-Export/Heat-load-in-sheep-exported-to-Middle-Eastern-feedlots/3183>
.....No pdf available

<https://www.mla.com.au/research-and-development/search-rd-reports/final-report-details/Live-Export/Heat-Management-in-the-Middle-East/3338>
.....No pdf available

<https://www.mla.com.au/research-and-development/search-rd-reports/final-report-details/Live-Export/Monitoring-Middle-East-feedlot-temperatures/3190>
.....No pdf available

6.2 Recent and previous conditions

A review of both recent and previous conditions within the approved arrangements associated with the export of sheep to the Middle East during the northern hemisphere summer, demonstrate that the industry has already implemented appropriate initiatives into many approved arrangements.

6.3 Administration of ASEL

There is scope to improve the administration of ASEL. A higher level of thinking in the regulatory framework would identify more than just breaches of ASEL. It would also identify the motive behind these breaches and consider opportunity (in terms of points of vulnerability in the regulatory framework). This, combined with a determined will to regulate should underpin the assurances that this review was tasked to outline.

6.3.1 DAWR's interaction with AMSA for vessel approval.

There is a great opportunity to develop a much more integrated relationship between AMSA and DAWR. There is no impediment to this, and goodwill on behalf of both parties.

6.3.2 The effectiveness of current reporting requirements.

Reporting is currently in a state of flux. The engagement of IOs changes many of the reporting dynamics. There will be a tentative period whereby teething problems are addressed and roles and reporting responsibilities find their natural place.

6.3.3 Additional assurance that approved arrangements are being met.

There are no additional assurances required other than that the regulatory function is undertaken. This must involve some level of checking. Given that resources are scarce, it is suggested that they be directed at things that actually make the most difference, and in essence that means stocking density. Random checks of weights could be considered. As mentioned previously, restricted stocking densities will require a greater level of policing.

7. Conclusions

It became apparent, very early on in the review that the industry has been shaped by a repeating cycle of reactivity. Furthermore, there has been a tendency for the regulator to focus on peripheral, easy to enforce aspects, and not the address the more difficult, core issues like stocking density.

In general, it is suggested that there be more focus on key issues, and less on peripheral issues that divert time and resources.

In keeping with this, there is no point amending (or adding) conditions to the approved arrangements, if the regulatory framework around the export of sheep to the Middle East during the northern hemisphere summer is ineffective.

The announced review of the regulatory capabilities and culture in the regulation of live exports will commence shortly. It is strongly suggested that this take a 'reform as you go' approach so that any initiatives take hold for this northern hemisphere summer period.

After having worked systematically through the terms of reference, the other feature that is apparent is the number of unevolved or evolving capabilities that litter the landscape. For the most part, the industry has completed a large body of quality R&D, but far too little of it has been picked up and turned into something operational. Industry should take this opportunity to identify any obstruction and forge forward with new technology, much of which can transform the industry and better prepare it for the challenges ahead.

8. Appendix

8.1 Further reading—List of references

6.1.1: Ventilation and the assessment of heat stress risk

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8.2 Abbreviations and acronyms

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| AAV | Australian Government Accredited Veterinarian |
| ALEC | Australian Livestock Exporters' Council |
| AMSA | Australian Maritime Safety Authority |
| ASEL | Australian Standards for the Export of Livestock (Version 2.3) |
| AVA | Australian Veterinary Association |
| eph | Exchanges per hour |
| HSRA | Heat stress risk assessment |
| HST | Heat stress threshold |
| IO | Independent observer |
| MARPOL | The International Convention for the Prevention of Pollution from Ships |
| MLA | Meat and Livestock Australia |
| ML | Mortality limit |
| PAT | Pen air turnover |