



Live sheep exports to or through the Middle East – Northern Hemisphere summer Draft RIS – December 2019

Submission from the
Australian Veterinary Association Ltd

3 February 2020

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Live sheep exports to or through the Middle East—northern hemisphere summer

Draft regulation impact statement - Submission from the Australian Veterinary Association

About Us

The Australian Veterinary Association (AVA) is the national organisation representing veterinarians in Australia. Our 9000 members come from all fields within the veterinary profession, including clinical practitioners, government veterinarians, and those who work in industry, research and teaching. Veterinary students are also members of the AVA.

Executive summary

The AVA has provided comment and supporting material on the 3 options proposed by the Live Animal Export Division, Department of Agriculture.

Although Option 2 is preferred by the Department, we do not believe that it goes far enough on its own to prevent adverse outcomes in high risk months.

The AVA proposes alternate recommendations (a combination of options 2 and 3) which should be able to achieve acceptable animal welfare outcomes, based on the science of heat stress in sheep. These are in line with AVA's previous key recommendations in the body of work we have submitted on this issue to date.

In previous submissions, the AVA has stated:

“Irrespective of stocking density, thermoregulatory physiology indicates that sheep on live export voyages to the Middle East during May to October will remain susceptible to heat stress and die due to the expected extreme climatic conditions during this time. Accordingly, voyages carrying live sheep to the Middle East during May to October cannot be recommended.”

The AVA maintains this position. The AVA refers the Department back to the previous AVA submissions and the data on which this statement was based.

Until recently, prolonged exposure of sheep to heat and humidity has been accepted as being part of a 'normal' voyage because mortality rate was the only trigger for investigation. It is apparent that even on low mortality shipments, there can be extended periods where sheep are suffering significant and prolonged heat stress, which is no longer viewed as acceptable animal welfare.

The AVA supports and applauds the paradigm shift recommended by Dr McCarthy for a move away from risk assessment based on mortality, to risk assessment based on animal welfare. AVA also supports the recommendation of the Heat Stress Risk Assessment (HSRA) Technical Reference Panel (the Panel), for implementation of a risk assessment based on 2% probability that deck temperatures could exceed a sheep's Heat Stress Threshold (HST).

Consistent with the recommendations of the Panel, AVA has previously stated that our recommended approach is to determine the HST for the particular group of animals using Hotstuff, and then assess likely Wet Bulb Temperatures (WBTs) for locations throughout the proposed voyage including discharge points,

based on historical and predicted meteorological data. If the predicted environmental WBTs are likely to exceed the calculated HST, then the conclusion should be that the voyage does not proceed. Where there is insufficient or inconclusive meteorological data, the precautionary principle should always be employed to ensure the welfare of the animals is prioritised. Certain times of the year are a known risk (May to October). Further, this heat stress can occur at any time of the year when shipments cross the equator, and for that reason HotStuff should be applied to all voyages to the Northern Hemisphere in the way described above, in all months of the year. This will be even more important into the future, given that climate change is expected to result in an increased frequency of extreme heat events.

The AVA was a stakeholder in the HSRA review, and strongly recommends that the recommendations of the HSRA Technical Reference Panel be implemented as proposed in Option 3. As stated in the AVA *Submission to the Draft Report by the (HotStuff) Technical Reference Panel*⁷, the Panel's recommendations should be implemented by the government without delay for every future live export shipment.

There is no need to undertake a further prolonged review of the HSRA (as proposed in section 4.2.1 of the draft RIS, to be completed in 2021). This represents an unnecessary delay, as the revised HotStuff model (version 4) is already capable of providing the key information required (ie calculation of HSTs).

RIS Option 1 – Regulatory Status Quo

This option is not supported by the AVA as it places sheep at unacceptably high risk during the entire Northern Hemisphere summer.

RIS Option 2 – Prohibition from 1 June to 14 September to all ports with additional prohibited periods for Qatar and Oman

In accordance with AVA's previous recommendations, **the AVA supports (in part) the implementation of cessation in shipping during the highest risk months.** We are pleased to note the extended periods 15 May to 22 September for journeys to Qatar and potentially to Bahrain, and an earlier prohibition throughout the whole of May for journeys to Oman. The AVA however maintains that for *all* Middle Eastern destinations, the period of prohibition should be modified to ensure that granting of export permits ceases on a date in May such that sheep are not on the water for any days in June.

The AVA supports the requirement for exporters to place automated data (WBT) logging equipment on board and report that data to the department, as well as behavioural data. This should occur at least for the months May to October (inclusive), and in all months on any voyages crossing the equatorial zone. WBTs should be recorded in a range of locations across the decks to ensure data from the hottest locations is also captured.

The AVA supports the removal of a requirement to use the existing HSRA model based on mortality, **however does not support a complete removal of the need to undertake an HSRA.**

Consistent with our [submission](#) in October 2019, **the AVA supports a defined period of prohibition, to give the community and industry certainty, provided it is combined with implementation of the revised HSRA model to manage the heat stress risks in the other months.** This risk assessment will be even more important going forward, given that climate change is expected to lead to an increased frequency of extreme heat events.

RIS Option 3 – Implementation of the revised HSRA model

The AVA supports adoption of Option 3 in combination with Option 2, provided that:

- Risk settings are based on heat stress thresholds (HSTs) instead of mortality thresholds, and
- The risk assessment is based on 2% probability that deck temperatures could exceed a sheep's HST, and
- Option 3 is implemented in combination with the modified version of Option 2 that AVA has recommended.

Introduction

Export of livestock from Australia by ship has been occurring since the 1960s. During this time, the Australian community has expected the Department of Agriculture to regulate the industry to ensure that acceptable animal welfare standards were being met. This includes within Australia during preparation and loading of livestock, during voyages of ships bound for equatorial and northern hemisphere countries, and during handling and slaughter in destination countries.

The AVA has a policy on Live Animal Export which was formulated with input from all members, ratified in July 2016, and which states:

“Ideally, Australian food animals should be slaughtered as close to the site of production as practicable to minimise transport and handling stress, and to ensure they are protected by appropriate and enforceable animal welfare and slaughter standards.”

It also states that, where live export occurs:

“Effective operational protocols must be in place at all times to safeguard the welfare of exported animals. These protocols must ensure humane animal transport, handling and slaughter practices in accordance with best practice; and include accreditation of abattoirs, training of employees and the implementation of an independent animal welfare auditing process.

Animals should not be subjected to prolonged land transport prior to exportation”¹

The unacceptable images of dead and dying sheep taken from five different live export voyages from Australia to the Middle East in 2017, shown on the television program *60-Minutes*² in April 2018, revealed failures by the Department and industry to meet Australian animal welfare standards, OIE animal welfare requirements³, and Australian community expectations. As stated on page 18 of the draft RIS: *“Future surveys found that over 80% of the public found live animal exports moderately to extremely concerning, and that 60% thought live animal exports should be banned.”*

Over the past 2 years, the AVA has undertaken a large amount of work and prioritised our resources in order that we could articulate sound, science-based recommendations for animal welfare improvements in the live export industry. To date we have submitted the following body of work:

- A short review of space allocation on live export ships and body temperature regulation in sheep⁴
- AVA submission to the ASEL Stage 2 Issues Paper⁵
- AVA Submission to the Heat Stress Risk Assessment (HotStuff) Issues Paper⁶
- AVA Submission to the Draft Report by the (HotStuff) Technical Reference Panel⁷
- AVA Submission to the Proposals and Conditions for Live Sheep Exports during the Northern Hemisphere Summer⁸
- AVA Submission to Proposed Conditions for Live Sheep Exports during September and October 2019⁹
- AVA response - Live Sheep Exports to the Middle East Policy Options – October 2019¹⁰

1 Source: <https://www.ava.com.au/policy-advocacy/policies/miscellaneous-welfare-issues-animal-export/live-animal-export/>

2 Source: <https://9now.nine.com.au/60-minutes/sheep-ships-and-videotapes/5c6e8bce-b910-4287-87f7-2ac7fa5a80eb>

3 Source: <https://www.oie.int/en/animal-welfare/animal-welfare-at-a-glance/>

4 Source: https://www.ava.com.au/siteassets/advocacy/ava-literature-review-live-sheep-export-may-2018_final_1.pdf

5 Source: https://www.ava.com.au/siteassets/advocacy/ava_comment_on_asel_stage-2-issues-paper.pdf

6 Source: <https://www.ava.com.au/siteassets/advocacy/ava-hotstuff-submission.pdf>

7 Source: <https://www.ava.com.au/siteassets/advocacy/improving-animal-welfare/ava-response-to-hsra-technical-panel-review-1-03-19.pdf>

8 Source: https://www.ava.com.au/siteassets/advocacy/improving-animal-welfare/ava-response-to-proposed-2019-summer-trade-arrangements_final.pdf

9 Source: <https://www.ava.com.au/siteassets/advocacy/improving-animal-welfare/ava-response-to-options-for-sep-oct-2019.pdf>

10 Source: <https://www.ava.com.au/siteassets/advocacy/improving-animal-welfare/ava-response-live-sheep-exports-to-the-middle-east.pdf>

Proposed RIS Options

In the discussion below, the AVA provides comment on the 3 options proposed in the draft RIS, and proposes alternate recommendations which should be able to achieve acceptable animal welfare outcomes. These are in line with AVA's previous key recommendations in the body of work we have submitted to date, i.e:

Key AVA recommendation 1

"Irrespective of stocking density, thermoregulatory physiology indicates that sheep on live export voyages to the Middle East during May to October will remain susceptible to heat stress and die due to the expected extreme climatic conditions during this time. Accordingly, voyages carrying live sheep to the Middle East during May to October cannot be recommended".¹¹

The AVA refers the Department back to the previous AVA submissions and the data on which this statement was based.

Key AVA recommendation 2

"Heat stress can occur at any time of the year when shipments cross the equator, and for that reason the HotStuff Model should be applied to all voyages to the Northern Hemisphere, in all months of the year. Even summer-acclimatised sheep travelling in the cooler months of the Northern Hemisphere are at risk of heat stress while crossing the Equator".¹⁹

The data available from Mortality Investigation Reports, Independent Observer Report Summaries and FOI documents clearly show that heat stress occurs in sheep as they cross the equator at all times of the year, and in the Middle East during the months of May to October¹². Unpublished data, [such as that cited in McCarthy (2005) and Norman (2014, 2015, 2016) and Independent Observer, climatic and sheep physiological data collected during 2018 and 2019 voyages] supports the limited published data.

RIS Option 1

Policy option 1 proposes a return to the regulatory status quo, with no measures to address heat stress risks.

This option is not supported by the AVA as it places sheep at unacceptably high risk during the entire Northern Hemisphere summer.

As stated on page 20 of the draft RIS: *"If ambient temperatures are very hot, as they can be during June to September (inclusive) even one sheep on a deck could experience conditions that result in heat stress and poor welfare.... The Bureau's analysis demonstrates that the risk of temperature extremes is 5% or more during and beyond the moratorium period. For example, the risk of extreme temperatures in September is as high, or higher than the risk in June."*

Thus, the option of taking no action to address heat stress risks is not supported.

¹¹ Source: https://www.ava.com.au/siteassets/advocacy/ava-literature-review-live-sheep-export-may-2018_final_1.pdf

¹² Source: <https://www.ava.com.au/siteassets/advocacy/ava-hotstuff-submission.pdf>

RIS Option 2

In accordance with Key AVA Recommendation 1, above, the AVA supports (in part) the implementation of cessation in shipping of sheep to or through the Middle East between the specified dates. We are pleased to note that for certain destinations, cessation of shipping will take place in May. However, as previously stated by AVA, we recommend that for *all* Middle East destinations, granting of export permits should cease on a date in May such that sheep are not on the water for any days in June. This is because:

- Mortality risks in June.** Historically, mortalities in sheep travelling to or through the Middle East have been greatest in June to September, whether month of voyage commencement (Figure 11) or discharge (Figure 2) is examined. Voyages that begin in May and end in June have historically resulted in a higher proportion of shipments with $\geq 0.5\%$ mortality compared with voyages undertaken wholly in May (Figure 3).
- Heat stress risk May to October.** The equatorial waters (latitudes 5°S to 5°N) of the Indian Ocean, extending to 15°N are at their maximum in May-June during the northward transit of the sun and prolonged periods of light winds. There are excessively high wet bulb temperatures from May to October in Persian Gulf and Red Sea destinations with southernmost ports first affected in May, extending northwards in June. October is a transition month but still exhibits spells of hot and humid weather. Therefore, sheep that do not die will suffer moderate to extreme heat stress for days to weeks during any voyage to the Middle East in May to October.

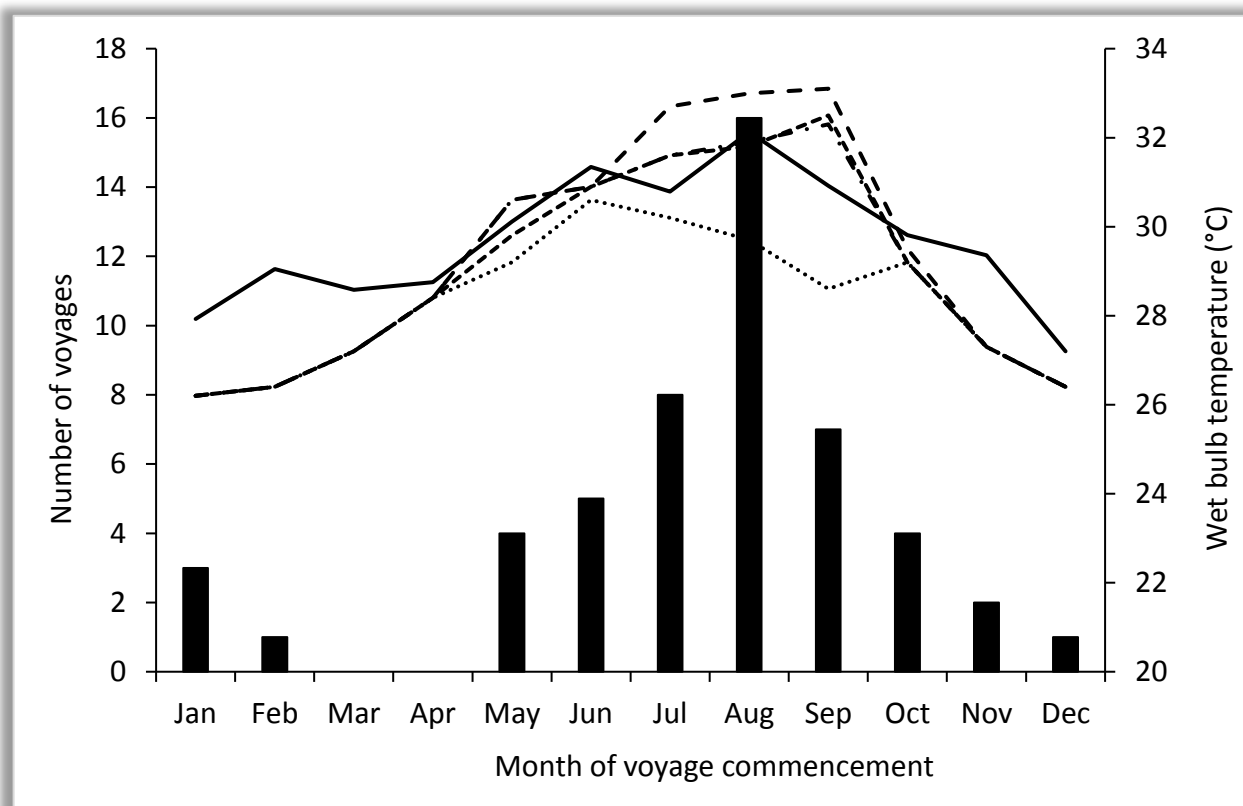


Figure 1. Number of voyages ($n=51$; black columns), by month of voyage commencement, when there were $> 15,000$ sheep on the ship from Australia to the Middle East between 2005 and 2017 and total sheep mortality rates were $\geq 1.5\%$ and voyage weather 98th percentile wet bulb temperatures for Kuwait (— • —), Doha Qatar (— — —), Dubai UAE (— — —), Muscat Oman (••••) and Aqaba Jordan (—). (Source: https://www.ava.com.au/siteassets/advocacy/ava-literature-review-live-sheep-export-may-2018_final_1.pdf and (Stacey 2017)).

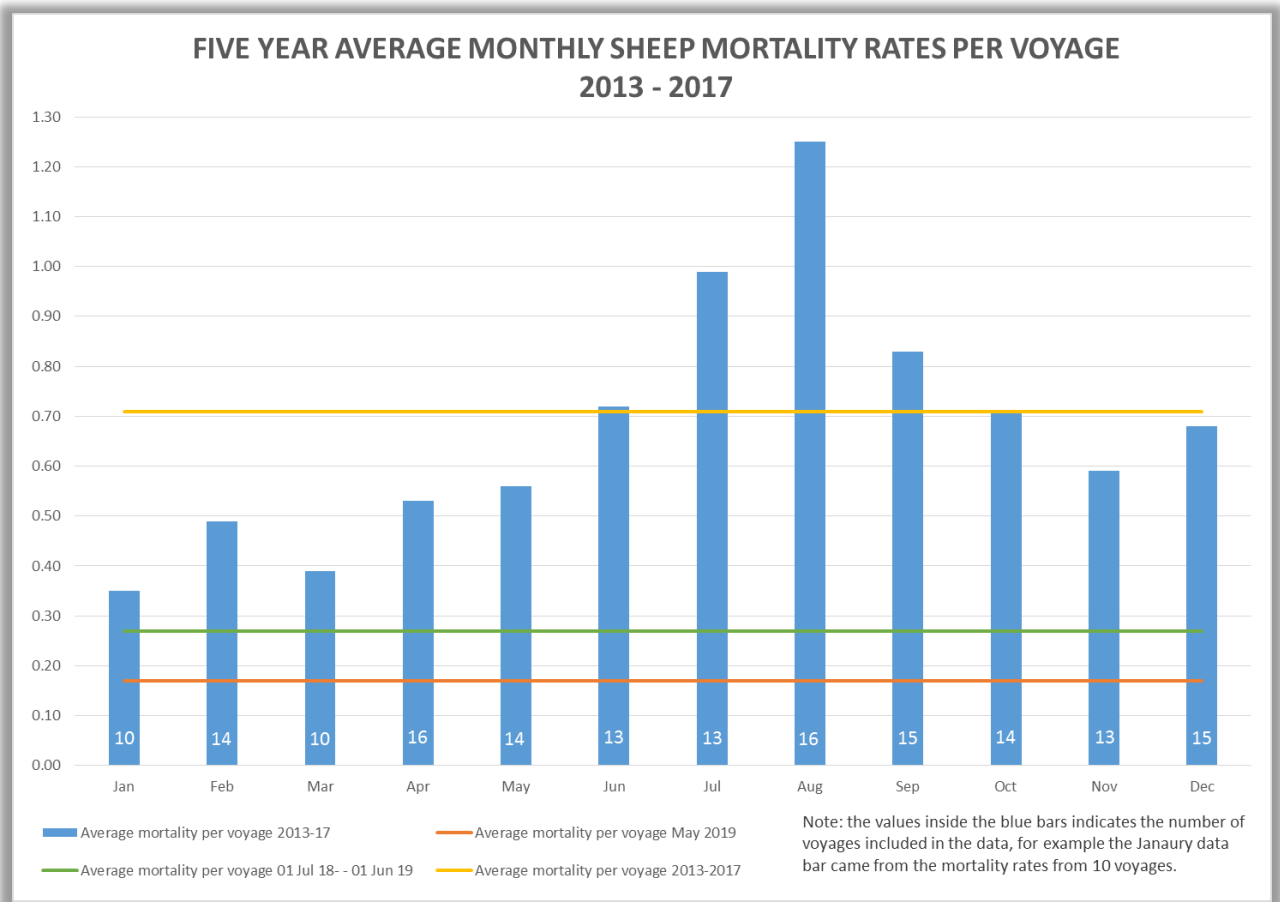


Figure 2. Five Year Average Monthly Sheep Mortality Rates Per Voyage. Data for the graph is drawn from the Reports to Parliament on Live Exports which reports voyages by month of discharge rather than date of departure. The graph represents 163 voyages from Australia to Middle-Eastern destinations as indicated by the values inside the blue bars. (Source: DAWR Proposed Conditions for Live Sheep Exports to the Middle East during September and October 201913).

13 Source: <http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/history/review-northern-summer/sheep-middle-east>

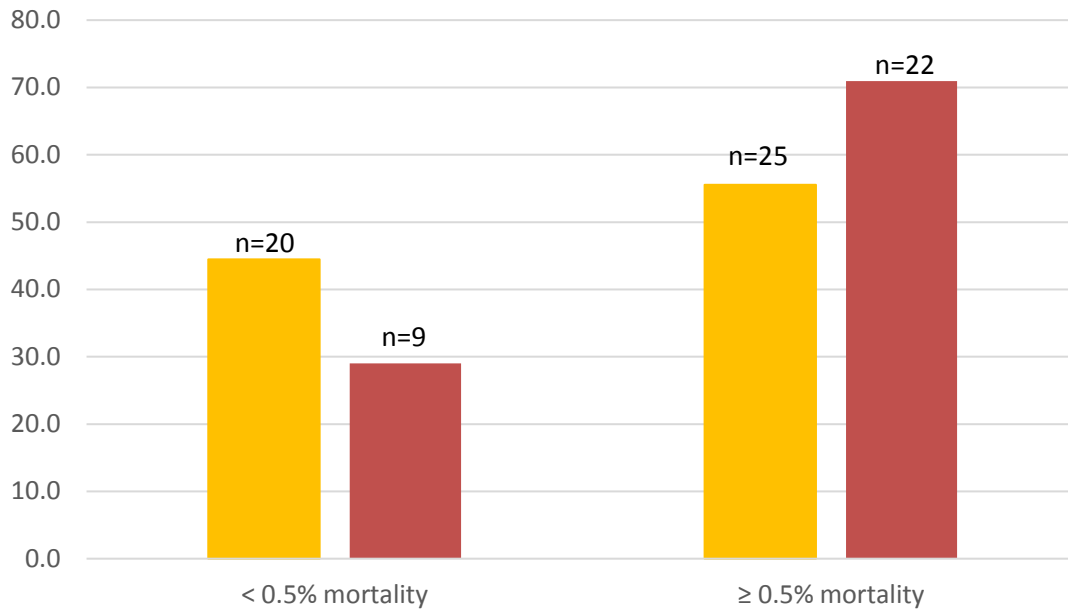


Figure 3. Proportion of voyages to/through the Middle East exhibiting < 0.5% or ≥ 0.5% sheep mortalities in any May arrivals (yellow columns) vs May departures with June arrivals (red columns) between 2005 and 2018.

Supporting information from 2018 and 2019 voyages

We refer the Department back to our previous [submission](#) (October 2019) and the summaries of IO reports presented therein (pages 13-26 inclusive).

As previously stated: where the climate is adverse such that the WBT is greater than the sheeps' heat stress threshold, the implications are that sheeps' core body temperatures remain elevated 24 hours a day, as do their respiratory rates in an attempt to thermoregulate, and this can extend for days and even weeks without respite (Stockman 2006, Beatty, Barnes et al. 2008) (AVA 2018, AVA 2018).

For this reason and based on the supporting data given above and previously, it is important that Policy Option 2, if adopted, is modified to ensure that granting of export permits ceases on a date in May such that sheep are not on the water for any days in June, for all Middle East destinations.

The AVA also supports the requirement for exporters to place automated data (WBT) logging equipment on board vessels and report that data to the department, in all months on any voyages crossing the equatorial zone. WBTs should be recorded in a range of locations across the decks to ensure data from the hottest locations is also captured.

Supporting information from the Bureau of Meteorology (BOM) report included in the draft RIS.

Extract from the AVA's previous [submission](#) (October 2019): Heat stress risk May to October:

The equatorial waters (latitudes 5 °S to 5 °N) of the Indian Ocean, extending to 15 °N are at their maximum in May-June during the northward transit of the sun and prolonged periods of light winds, and "heat and humidity levels rapidly build across all Middle Eastern ports during the period from May through to June" (Maunsell-Australia 2003). There are excessively high wet bulb temperatures from May to October in Persian Gulf (Doha, Dubai and Kuwait, Strait of Hormuz, Persian Gulf) and Red Sea destinations (Aqaba, Bab el Mandeb Strait, Red Sea) with southernmost ports first affected in May, extending northwards in June (Maunsell-Australia 2003, Stacey 2017, Stacey 2017). October is a transition month but still exhibits spells of hot and humid weather (Maunsell-Australia 2003). Therefore, sheep that do not die will suffer moderate to extreme heat stress for days to weeks during any voyage to the Middle East in May to October.

The Bureau of Meteorology report produced in association with the draft RIS supports all the AVA findings above (Bureau-of-Meteorology 2019):

BOM Middle East live sheep trade climate analysis (2019) states:

- *"Trends toward earlier onset dates and later cessation dates of the occurrence of higher wet bulb temperatures suggest the risk window for higher wet bulb temperatures during the northern summer is increasing in the Strait of Hormuz and Persian Gulf."* (Source: p 5, 27 BOM Middle East live sheep trade climate analysis, 2019)
- *"Wet bulb temperatures in the Gulf of Aden and into the Red Sea start from higher temperatures in April, warming to 28°C slightly more quickly in May and June than in the Persian Gulf"* (quote from p 28, illustrated in Figure 4-11 on p 38 of BOM Middle East live sheep trade climate analysis, 2019).
- The average first day of the year when WBT does not drop below 28°C in Strait of Hormuz occurs 13-17 June depending on the IOD (p 42 of BOM Middle East live sheep trade climate analysis). The average last day of the year when WBT does not drop below 30°C in Strait of Hormuz and Persian Gulf is early October depending on the IOD (p 42 of BOM Middle East live sheep trade climate analysis, 2019).
- There are higher WBTs in May, June and July in the Indian Ocean, Arabian Sea and Socotra under the influence of MJO (p 43, p 49 of BOM Middle East live sheep trade climate analysis). There are higher WBTs in October in the Gulf of Oman, Strait of Hormuz, Persian Gulf, Gulf of Aden and Red Sea under the influence of MJO (p 43 of BOM Middle East live sheep trade climate analysis, 2019).
- The comment that *"Rarely do wet bulb temperatures stay above 28°C all night in the Red Sea"* (p 28 of BOM Middle East live sheep trade climate analysis, 2019) must be read in light of the fact that on live export ships, there is little diurnal variation in WBT below decks where animals are housed. This is clearly demonstrated in Figure 0.5 Voyage 1 taken from *Investigating Ventilation Efficiency on Live Sheep Vessels* (p18, Maunsell Australia, 2004) showing little diurnal and day-to-day variation in a June-July voyage (Figure 1). Interestingly, note the presence of temperature and relative humidity loggers on live animal export ships in 2004 measuring WBT 24 h/d. Mean deck WBT (taken from readings performed mid-morning) is representative of what happens all day and all night on enclosed livestock decks during voyages from Australia to the Middle East.

RIS Option 3

Policy option 3 proposes that a revised HSRA model would be adopted where risk settings were based on heat stress thresholds (HSTs) instead of mortality thresholds used in the current model.

The AVA supports the paradigm shift recommended by McCarthy for a move away from risk assessment based on mortality, to a risk assessment based on animal welfare. The AVA also supports a change in the way the Heat Stress Risk Assessment (HotStuff) model is implemented, so that it is used to calculate the risk of WBTs exceeding the heat stress threshold for the particular sheep on any proposed voyage, rather than only being used to calculate stocking density for the proposed voyage.

The AVA strongly supports the recommendation of the HSRA Review, for a risk assessment based on 2% probability that deck temperatures could exceed a sheep's HST.

For that reason, the AVA supports Option 3, provided risk settings are based on HSTs, and provided that Option 3 is implemented in combination with the modified version of Option 2 we have recommended.

Implementation of the HSRA (HotStuff) Model to determine the heat stress threshold is appropriate for every voyage that crosses the Equator carrying any livestock, regardless of estimated duration (short haul, long haul or extra-long haul). This has become even more important now that climate change has increased the risk of occurrence of extreme weather events.

This recommendation is in line with the recommendations made by the AVA in submissions to the ASEL Stage 2 Issues Paper¹⁴ and the HSRA (HotStuff) Review¹⁵.

Research was undertaken more than 15 years ago to measure and mathematically model data from (a) many voyages carrying sheep and cattle from Australia, and (b) experiments performed in controlled climate rooms, to define heat stress thresholds and mortality limits for various classes of sheep and cattle (Maunsell-Australia 2003, Barnes, Beatty et al. 2004, Maunsell-Australia 2004, McCarthy 2005, Stockman 2006, Beatty, Barnes et al. 2008). The end product, HotStuff, has been refined since (Figure4) (Stacey 2011, Ferguson and Lea 2013, Stacey 2017, Stacey 2017) and historically has been used, where required by legislation (EAN 2012-08¹⁶ and EAN 2018-06¹⁷), to predict risk of mortality due to heat stress on selected voyages from Australia.

Nevertheless, HotStuff can be also used to predict the heat stress threshold for different lines of stock and should be applied in all months of the year where live animal export vessels cross the Equator. The equatorial waters (latitudes 5°S to 5°N) of the Indian Ocean, have a relatively uniform WBT around 25-26°C with a slight peak from April to June when trade winds are weaker (Maunsell-Australia 2003). South of latitude 5°S there are periods between March and May when the mean WBT is close to 26°C with occurrences in April and other months of the year when 28°C WBT is reached (Maunsell-Australia 2003).

Note that HotStuff can already perform this function – another prolonged review extending out to 2021, as proposed in section 4.2.1 of the draft RIS, is not warranted. The recommendations of the HSRA Review Panel in their 2019 review should be implemented without delay.

14 Source: https://www.ava.com.au/siteassets/advocacy/ava_comment_on_asel_stage-2-issues-paper.pdf

15 Source: <https://www.ava.com.au/siteassets/advocacy/ava-hotstuff-submission.pdf>

16 Source: <http://www.agriculture.gov.au/export/controlled-goods/live-animals/advisory-notice/2012/2012-08>

17 Source: <http://www.agriculture.gov.au/export/controlled-goods/live-animals/advisory-notice/2018/2018-06>

Base Parameter	Bos taurus		Bos indicus			Merino		Awassi	
	beef	dairy	beef	25%	50%	adult	lamb	adult	lamb
Weight (kg)	300	300	300	300	300	40	40	40	40
Core Temperature (degrees C)	40	40	40	40	40	40	40	40	40
Condition (Fat Score)	3	3	3	3	3	3	3	3	3
Coat	mid	mid	N/A	N/A	N/A	shorn	shorn	hairy	hairy
Acclimatisation WB Temp	15	15	15	15	16	15	15	15	15
Base HST (degrees C)	30	28.2	32.5	31.25	31.875	30.6	26.7	31.9	28.6
Base ML (degrees C)	33.2	32.9	36.0	34.60	35.30	35.5	35.20	36.1	35.90
Beta distribution lower limit (degrees C)	30.31	29.88	34.30	32.30	32.30	33.58	33.17	34.52	34.15
Beta distribution upper limit (degrees C)	34.74	34.51	36.90	35.82	35.82	36.52	36.29	37.03	36.83

Figure 4. Heat stress thresholds and mortality limit values for “standard animals” of different classes of sheep and cattle defined in the heat stress risk assessment model, HotStuff V4 (Stacey 2017).

The HST generated by HotStuff is defined as:

“the maximum ambient wet bulb temperature at which heat balance of the deep body temperature can be controlled using available mechanisms of heat loss’. That is; when the local air wet bulb temperature reaches any animal’s HST, the animal is on the verge of becoming stressed. As implied above, incipient stress in this sense means the first uncontrolled rise in core body temperature. We take this as being 0.5° C above what the core temperature would otherwise have been” (Maunsell-Australia 2003).

The HST generated by HotStuff is the same value designated “HST 2” by Catherine Stockman in her research into heat stress in sheep (Table 1) (Stockman 2006).

Table 1. Heat stress threshold definitions (Stockman 2006).

	HST definition
HST 1	The daily mean wet bulb temperature on the day that the daily mean core body temperature first significantly increases over pre-heat values
HST 2	The daily mean wet bulb temperature on the day that the daily mean core body temperature first significantly increases 0.5°C above pre-heat values
HST 3	The daily mean wet bulb temperature on the day that the daily mean core body temperature first significantly increases 1°C above pre-heat values

Option 3 on its own, (without an accompanying defined period of prohibition as set out in Option 2), poses risks, due to the potential for varying interpretation and implementation of the HSRA model. There are varying opinions on what is an acceptable duration of open-mouth panting (Refer previous AVA [submission](#), pages 30, 31). Nevertheless, there is general agreement that the **onset of phase 1 panting is a good indicator of the onset of thermal stress** and the **onset of phase 2 panting indicates severe heat load and risk of respiratory alkalosis** (Figure 5) (AVA 2018).

The AVA believes that sheep should not be exposed to HST 3 (open mouth panting) even for short periods on voyages to or through the Middle East. This is because they will have already suffered moderate heat stress up until reaching HST 3, and are unlikely to be able to easily return to thermoneutrality, due to lack of respite in temperatures overnight and lack of day to day variation in WBT. This is very different to sheep open-mouth panting on land, when they will be able to shed their heat load at night.

On sea voyages to the Middle East, once sheep reach HST 3 (open-mouth panting and severe heat stress), they are on the tipping point of irreversible heat stress. If conditions should change for the worse or there is a sudden spike in temperatures, these animals are at high risk of suffering extreme heat stress and dying. Given the Department's aim is now to reduce poor animal welfare outcomes (not just reduce mortality), months where any duration of open-mouth panting has been recorded should be seen as high risk months for subsequent voyages.

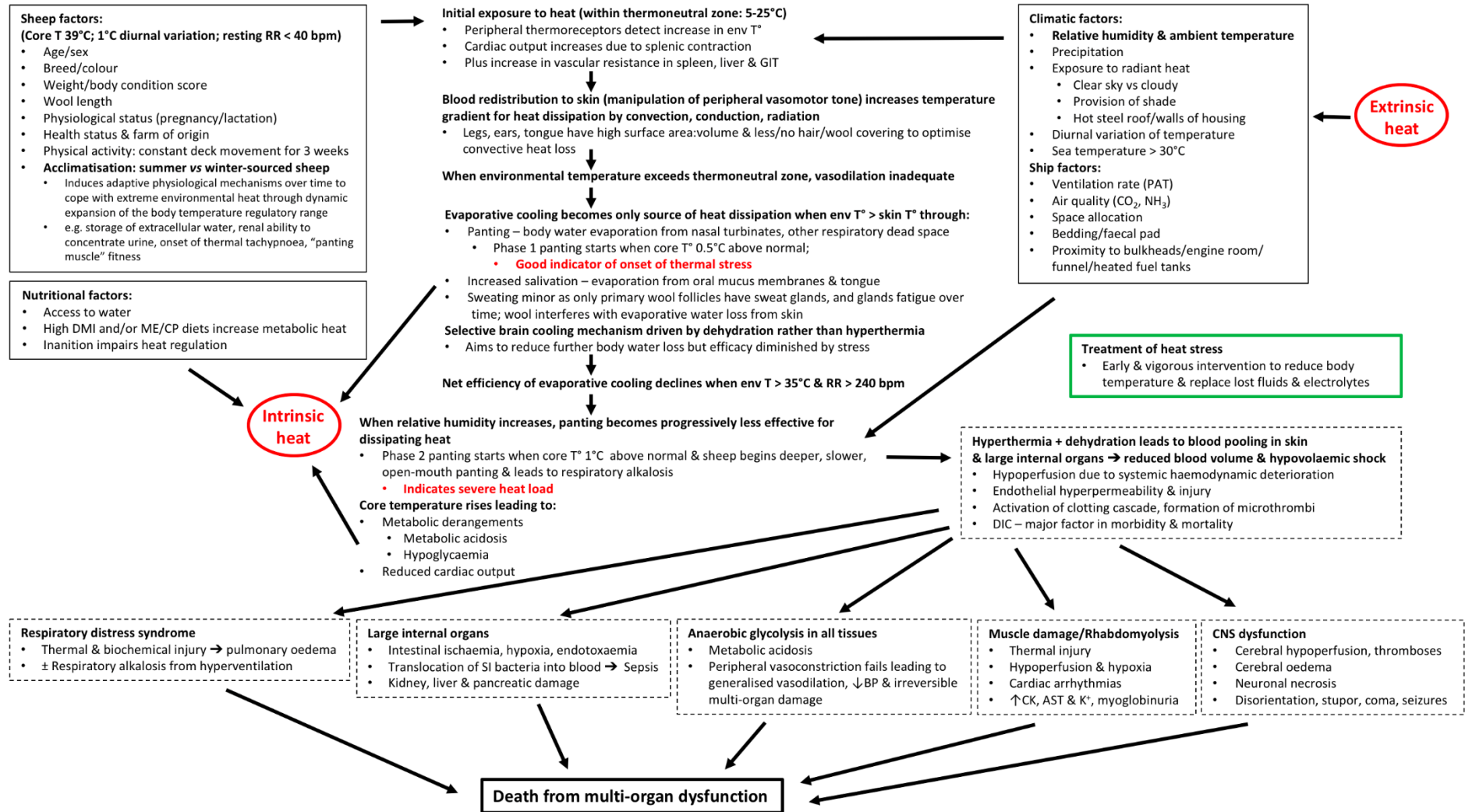


Figure 5. Pathogenesis of heat stress in sheep (appears as Figure 2 in (AVA 2018).

The AVA has presented many graphs illustrating how the adjusted Heat Stress Threshold in HotStuff predicts the likelihood of heat stress in sheep (Figures 14-18(AVA 2018) and made recommendations in that submission including:

“It is inappropriate for sheep or any other animals to be exposed to long periods of heat stress, due to the impact of cumulative heat load on normal physiological processes. Sheep should never be exposed to HST 3, even for short periods. Sheep should not be exposed to HST 2 for more than 3 consecutive days where there is no diurnal variation in temperature. Diurnal variation allows sheep to return to their thermoneutral zone and for respiratory rates to return to resting range at night. Otherwise, sheep can start dying within 3 days of being exposed to hot, humid weather, as heat load is cumulative. This duration of permissible exposure should be further reduced in the presence of other welfare imposts and/or co-morbidities as these will further reduce the animal’s ability to cope. This is consistent with the 5 Domains approach to assessing welfare which looks at severity and duration of welfare compromise, as well as the anticipated integrated impact of the combined welfare impacts on the animal’s mental state.”

“Death of sheep secondary to heat stress during live shipping is not just of concern during “heat wave conditions” but a major cause of mortality during all shipments of sheep across the Equator. It is apparent that even on low mortality shipments, there are extended periods where sheep are suffering significant and prolonged heat stress, which is not acceptable. Further, this can occur at any time of the year when shipments cross the equator, and for that reason the HotStuff Model should be applied to all voyages to the Northern Hemisphere, in all months of the year. Even summer-acclimatised sheep travelling in the cooler months of the Northern Hemisphere are at risk of heat stress crossing the Equator.”

Table2 and **Figure 6** (both below) correlate comments made by the IO in daily reports (FOI LEX-755 pages 148-418) and adjusted HSTs for sheep that could have been on a voyage from Australia to the Middle East in May 2018. This voyage falls into a category that has historically been regarded as a low mortality shipment (0.27%); however it can be seen that sheep experienced prolonged and consistent exposure to WBTs above their heat stress thresholds over periods of many days.

Other shipments in April and May 2018 (space allocation ASEL + 17.5%; see Error! Reference source not found.-Error! Reference source not found. in **previous submission**) and 2019 (space allocation k-value 0.033; see Error! Reference source not found. in **previous submission**) also provide examples of heat stress occurring in sheep in these months.

Sheep are exceedingly stoic, and although fewer animals may have died in these examples, this does not negate the fact that the surviving animals would have suffered prolonged effects of heat stress throughout these journeys. The Australian Veterinary Association, in submissions into the ASEL and HotStuff reviews, has described this prolonged exposure of sheep to heat stress without respite as unacceptable.^{18 19}

The AVA therefore supports adoption of Option 3, provided that:

1. Risk settings are based on heat stress thresholds (HSTs), and
2. The risk assessment is based on 2% probability that deck temperatures could exceed a sheep’s HST, and
3. Option 3 is implemented in combination with the modified version of Option 2 AVA has recommended.

18 Source: <https://www.ava.com.au/siteassets/advocacy/ava-hotstuff-submission.pdf>

19 Source: <https://www.ava.com.au/siteassets/advocacy/improving-animal-welfare/ava-response-to-hsra-technical-panel-review-1-03-19.pdf>

Table 2. Adjusted heat stress threshold (HST) wet bulb temperature (WBT, °C) for an example of sheep that could have travelled from from Adelaide and Fremantle to Israel and Jordan in May 2018. Data was derived from Independent Observer Daily Reports (Source FOI LEX-755 pages 148-418). (F = factor applied in HotStuff model calculations, std = standard).

Age of Merino sheep, month & destination	Weight (kg)	F wt	Core temp (°C)	Fat score	F fat	Fleece length	F coat	Zone	Zone temp (°C)	F zone	Base HST (°C)	Tcore-HST (°C)	Adjusted HST WBT (°C)
Standard adult Merino	40	1.00	40	3	1	shorn	1	std	15	1.00	30.6	9.40	30.60
Adult sheep to Israel, May	55	1.07	40	3	1	shorn	1	3	12.3	1.07	30.6	10.69	29.31
Adult rams to Israel, May	70	1.12	40	3	1	shorn	1	2	11	1.1	30.6	11.56	28.44

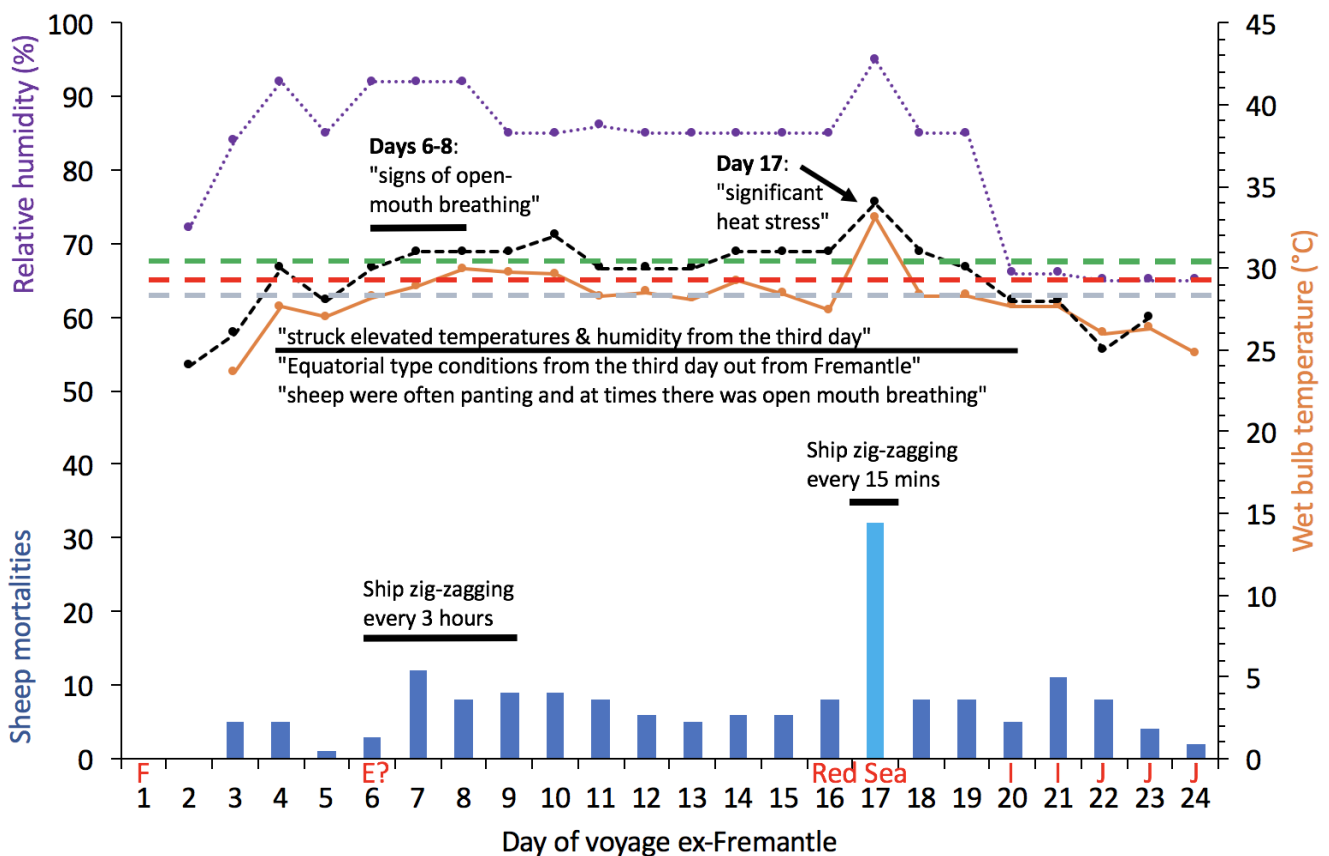


Figure 6. Mean mid-morning wet bulb temperature (WBT, °C) of all decks (solid orange line), maximum WBT measured by Independent Observer (dashed black line), mean deck relative humidity (dotted purple line) and daily sheep mortalities (blue columns; pale blue column: deaths not reported on day 17, so figure was calculated as the difference between total and sum of other daily deaths) by day for a voyage on the Bader III (sheep loaded on double-tiered open decks) undertaken in **May 2018** from Fremantle (F) to Israel (I) and Jordan (J) where 169 (0.27%) of 62,668 sheep died, showing heat stress threshold (HST 30.6°C, dashed green line) for a “standard” sheep (Stacey 2017b), and the heat stress threshold for 55 kg mature Merino sheep from Zone 3 (29.3°C; dashed red line) and 70 kg Merino rams from Zone 2 (28.4°C; dashed grey line) according to assumptions described in **Table 2**. The ship crossed the Equator (E) around day 6. The horizontal black lines and comments were obtained from the IO Shipboard Daily Reports of the voyage (Source: FOI LEX-755 148-418).

Conclusion

The AVA has provided comment and supporting material on the 3 options proposed by the Department, and proposes alternate recommendations which should be able to achieve acceptable animal welfare outcomes, based on the science of heat stress in sheep. These are in line with AVA's previous key recommendations in the body of work we have submitted to date.

The data available from Mortality Investigation Reports, Independent Observer Report Summaries and FOI documents clearly show that heat stress occurs in sheep as they cross the equator at all times of the year, and in the Middle East during the months of May to October²⁰. Unpublished data, [such as that cited in McCarthy (2005) and Norman (2014, 2015, 2016) and Independent Observer, climatic and sheep physiological data collected during 2018 and 2019 voyages] supports the published data.

As such, the AVA supports a modified version of Option 2, in combination with Option 3, as outlined in our discussion and executive summary.

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²⁰ Source: <https://www.ava.com.au/siteassets/advocacy/ava-hotstuff-submission.pdf>

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