Final report

Guideline and manuscript for Meat Hygiene Assessment 3 (Product Monitoring)

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Abstract

This project has delivered a journal article titled “Microbiological quality of Australian beef, sheep and pork carcases, cuts and offals” which presents the data from carcases, bulk meat, primals and offal from twelve export establishments (beef, sheep and pork) which participated in an industry trial (AMPC 2018.1070). A total of 27,157 microbial results were analysed to give a snapshot of the status of the Australian meat industry in 2017-18 and showed that there has been a meaningful improvement in total bacterial loadings, reflecting significant improvements in livestock handling, establishment infrastructure, operator training and the uptake of HACCP systems throughout the industry. This article builds on the evidence base established by previous MLA-funded microbiological baseline surveys of the red meat industry.

SARDI provided technical support to the red meat industry and the Department of Agriculture, Fisheries and Forestry for the transition to Meat Hygiene Assessment 3 (Product Monitoring). SARDI delivered an information brochure, a How-To Guide and three webinars to the industry in preparation for the start date of 1st July 2023 and as of the 14th of July 2023, 94% of Tier 2 export establishments (including wild game and independent boning rooms) have successfully transitioned to Meat Hygiene Assessment 3 (Product Monitoring).

Executive summary

Background

Historically, the red meat industry, through Meat and Livestock Australia, has completed and published industry baseline studies which are snapshots of the microbiological performance of the industry. In 2017/18, a large industry trial was conducted as part of AMPC Project 2018.1070 and the resultant dataset of 27,157 results for carcases, bulk meat, primals and offal needed to be similarly published in the peer-reviewed literature to put forward Australia's food safety status, especially since the last industry-wide baseline survey was completed eleven years ago in 2012.

Since 2017, a series of projects have been completed which have modernised the way in which meat products are monitored, both microbiologically and visually. A review of the Meat Hygiene Assessment system was completed and a new risk-based system of visual product monitoring was proposed by SARDI and supported by industry and the Department of Agriculture, Fisheries and Forestry (DAFF). After an industry trial in 2021, the Meat Hygiene Assessment 3 (MHA 3) (Product Monitoring) system was approved for implementation industry-wide by DAFF and there was a need for technical assistance to help Tier 2 export establishments transition to MHA 3 (Product Monitoring) and amend their Approved Arrangements.

Objectives

1. To prepare a journal article on the microbial data collected from an industry trial (AMPC 2018.1070).
2. To provide an information brochure, a how-to guide and webinars to assist industry in the implementation of MHA 3 (Product Monitoring).

Methodology

- The journal article "Microbiological quality of Australian beef, sheep and pork carcases, cuts and offals" was written.
- A brochure "Modernising the Australian meat industry – big changes coming soon to MHA Product Monitoring" was prepared by SARDI and broadcast by AMPC to its members.
- A How-To Guide was developed to assist establishments in amending their Approved Arrangements to include MHA 3 (Product Monitoring). The How-To Guide was based on the trial protocol developed as part of AMPC project 2021.1091.
- Three industry webinars were delivered which presented the new aspects of MHA 3 (Product Monitoring) such as risk assessment of product lines/corrective actions and gave industry the opportunity to ask questions of SARDI. A total of 56 staff from 38 establishments attended the webinars.
- A close collaboration and alignment of documentation between SARDI and the Meat Exports team at DAFF was fostered through regular teleconferences.

Results/Key Findings

Regarding Objective 1, in addition to the points above under Methodology, the key message of the journal article was that there has been a meaningful improvement in total bacterial levels, reflecting significant improvements in livestock handling, establishment infrastructure, operator training and the uptake of HACCP systems throughout the Australian meat industry.

In terms of Objective 2, as of the 14th of July 2023, 94% of Tier 2 export establishments (including wild game and independent boning rooms) have successfully transitioned to MHA 3 (Product Monitoring). MHA 3 (Product Monitoring) data capture via DAFF's Meat Exports data collection system (MEDC) has been live since April 2023 and establishments have been successfully entering data with no issues reported to date.

Benefits to industry

The publication of the 2017/18 industry trial is a valuable resource when critical information is required by overseas markets and customers. In particular, the Australian industry and regulator have recently put forward an alternative microbiological monitoring system and having the data published in an international, peer-reviewed journal will assist in demonstrating the basis on which these regulatory changes are proposed when Australia's major trading partners review the revised system.

MHA 3 (Product Monitoring) is a system that is risk-based, allowing an establishment to focus on food safety plus areas of risk to their business. MHA 3 (Product Monitoring) also produces more targeted and actionable data. DAFF have conservatively forecasted a $3.2 million annual benefit to industry with the transition to MHA 3 (Product Monitoring) and the benefits include more useful data and Quality Control / Quality Assurance staff being able to proactively monitor potential trends, undertake investigations to improve the system and better interact with other departments.

Future research and recommendations

Under the banner of meat modernisation, microbiological monitoring and visual hygiene assessment systems for meat products have been reviewed and alternative systems proposed, trialled and implemented by industry. A further element requiring review is how slaughter and dressing processes are monitored, as part of MHA. Therefore, it is recommended that the way these processes are monitored, should be reviewed and a revised system developed. Such a revised process monitoring system should deliver reduced costs for compliance and will reflect the transitioning of the industry into risk-based inspection.

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1. Background

This project has two components: 1) preparation of a scientific article for a peer-reviewed international journal on the microbial data collected from an industry trial conducted in 2017/18 (AMPC 2018.1070) and 2) assistance for the red meat industry for the implementation of Meat Hygiene Assessment 3 (Product Monitoring).

1.1 Journal article

In the past, the red meat industry, through Meat and Livestock Australia (MLA), has funded four baseline studies, the most recent of which was 2012. These industry baseline studies are snapshots of the performance of the red meat industry and have always been published in the international, peer-reviewed literature. The industry baseline studies have also been used to chart important changes and improvements and are a valuable resource when critical information was needed by overseas markets and customers. For example, baseline studies have established that the prevalence and concentration of Shiga toxin-producing *E. coli* in Australian manufacturing meat is extremely low and subsequent risk assessments indicate that if all Australian trim exported to the United States of America was manufactured into "Aussie" hamburgers (no co-mingling with trim from other countries), they would cause less than 1 illness/decade in quick serve restaurants (Kiermeier et al. 2014).

In more recent years, the Australian red meat industry has been able to make favourable comparisons with other meat industries internationally regarding microbiological status of the meat and these are documented in AMPC Project 2018.1086 'Microbiological food safety and storage life of Australian red meat'. In 2017/18, a large industry trial was conducted (AMPC 2018.1070) and it was considered that the resultant dataset should be published to put forward Australia's food safety status in the international literature, especially in the absence of more recent industry-wide baseline surveys.

1.2 Support for transition to Meat Hygiene Assessment 3 (Product Monitoring)

Since 2017, a series of projects have been completed which have modernised the way in which meat products are monitored, both microbiologically and visually. In close collaboration with industry and AMPC, SARDI reduced significantly the number of Key Performance Indicators required for Product Hygiene Index reporting; introduced a more informative approach to microbiological monitoring and developed and trialled a risk-based system of visual product monitoring. The Meat Hygiene Assessment 3 (MHA 3) (Product Monitoring) system was approved for implementation industry-wide by the Department of Agriculture, Fisheries and Forestry (DAFF) with an implementation date of the 1st of July 2023. Some technical assistance was required to help establishments in learning about MHA 3 and transitioning their current Approved Arrangements. This project thus facilitated the provision of technical support and assistance to export establishments to transition to MHA 3 (Product Monitoring).

2. Objectives

1. To prepare a scientific journal article on the microbial data collected from an industry trial (AMPC 2018.1070).

2. To provide an information brochure, a how-to guide and webinars to assist industry in the implementation of MHA 3 (Product Monitoring).

3. Methodology

3.1 Journal article

The dataset from the industry trial covered:

- Twelve establishments (six beef, three sheep and lamb and three pork)
- A range of large and small establishments, identified by daily throughput
- Geographical location, spread across Australia
- Hot and cold boning
- Single-species versus multi-species establishments
- Collected every working day over 12 months
- Seasonality, due to the 12 month period.

The dataset comprised 27,157 microbiological results as shown below in Table 1.

Table 1: Number of microbiological results for beef, sheep and pigs and carcases, bulk meat, primals and offal from AMPC 2018.1070.

Species	Carcases	Bulk meat	Primals	Offal	Total
Beef	6,057	6,003	1,275	1,820	15,155
Sheep	3,693	2,891	555	1,266	8,405
Pigs	1,762	978	339	518	3,597
Total	11,512	9,872	2,169	3,604	27,157

A journal article was drafted and will be submitted to *Foods*, an international, scientific, peer-reviewed, open access journal of food science.

3.2 Support for transition to MHA 3 (Product Monitoring)

SARDI provided support to industry in the transition to MHA 3 (Product Monitoring) through:

- An information brochure informing the red meat industry of the roll-out of MHA 3 (Product Monitoring)
- A How-To Guide to facilitate the implementation of MHA 3 into establishments' Approved Arrangement
- Webinars run in February-March 2023 to provide more focused advice and to answer any points arising.

Over the period September 2022 – March 2023, SARDI and DAFF staff liaised closely via near-monthly Microsoft Teams meetings on the development of the How-To Guide and its incorporation in the Department's Guideline document and Meat Notice.

4. Results

4.1 Journal article

The journal article "Microbiological quality of Australian beef, sheep and pork carcases, cuts and offals" was drafted by Jessica Jolley, Andreas Kiermeier and John Sumner and has been submitted to the journal *Foods* for consideration. The journal article is attached in Appendix 8.1.

4.2 Support for transition to MHA 3 (Product Monitoring)

4.2.1 Brochure

In January 2023, a brochure *'Modernising the Australian meat industry – big changes coming soon to MHA Product Monitoring'* was prepared by SARDI and broadcast by AMPC to its members advising them of the key elements of MHA 3 and that assistance would be provided in two steps:

Step 1: A How-To Guide to facilitate the implementation of MHA 3 into the approved arrangement.
Step 2: Webinars run by SARDI in February-March 2023 to provide more focused advice and to answer any points arising.

The brochure is attached in Appendix 8.2.

4.2.2 How-To Guide

SARDI developed a How-To Guide to assist establishments in amending their Approved Arrangements to include MHA 3 Product Monitoring. The How-To Guide was based on the trial protocol developed as part of AMPC Project 2021.1091 and is attached in Appendix 8.3.

4.2.3 Webinars

A total of 56 staff from 38 establishments participated in three webinars hosted by AMPC on February 15, February 20 and March 8, 2023, in which a PowerPoint presentation was used to inform, particularly on 'new' aspects such as risk assessment of product lines/corrective actions and to stimulate questions; each participant received a copy of the PowerPoint presentation.

Participants were provided with an online questionnaire, to which twelve establishments responded by rating their satisfaction with the How-To guide and the conduct of the webinars on a 5-point scale. Participants were also able to comment on any aspect they considered relevant. Responses from all three webinars are summarised in Appendix 8.4, which indicate general satisfaction both with the How-To guide and the conduct of the webinars.

The Meat Modernisation team at DAFF held two webinars in April 2023 with industry to discuss MHA reform and SARDI provided the contents of Appendix 8.4 and the PowerPoint presentation delivered in the SARDI webinars to continue the aligned approach between industry and the regulator.

The liaison between SARDI/AMPC and DAFF proved effective in designing the presentations; making available the DAFF Guideline document to industry; and in providing early information on

a soft Go Live date (17 Apr 2023) for early adopters and a hard Go Live date (01 Jul 2023) for all Tier 2 establishments.

5. Conclusion

5.1 Key findings

The key message of the journal article was that there has been a meaningful improvement in total bacterial levels in Australian beef, sheep and pork, reflecting significant improvements in livestock handling, establishment infrastructure, operator training and the uptake of HACCP systems throughout the Australian meat industry.

As of the 14th of July 2023, 94% of Tier 2 export establishments (including wild game and independent boning rooms) have successfully transitioned to MHA 3 (Product Monitoring). MHA 3 (Product Monitoring) data capture via DAFF's Meat Exports data collection system (MEDC) has been live since April 2023 and establishments have been successfully entering data with no issues reported to date. MHA 3 reporting elements (Power BI PHI reports and Expert Service dashboards) will be updated in the third quarter of 2023 (per comms from DAFF).

5.2 Benefits to industry

The publication of the 2017/18 industry trial is a valuable resource for when critical information is required by overseas markets and customers. In particular, the Australian industry and regulator have recently put forward an alternative microbiological monitoring system and having the data published in an international, peer-reviewed journal will assist in demonstrating the basis on which these regulatory changes are proposed when Australia's major trading partners review the revised system.

MHA 3 (Product Monitoring) is a system that is risk-based, allowing an establishment to focus on food safety plus areas of risk to their business, whilst making more efficient use of labour. MHA 3 (Product Monitoring) also produces more targeted and actionable data. DAFF have conservatively forecasted a $3.2 million annual benefit to industry with the transition to MHA 3 (Product Monitoring) and the benefits include more useful data and Quality Control / Quality Assurance staff being able to proactively monitor potential trends, undertake investigations to improve the system and better interact with other departments.

6. Future research and recommendations

Under the banner of meat modernisation, the microbiological monitoring and visual hygiene assessment systems for meat product have been reviewed and alternative systems proposed, trialled and implemented by industry. The final element requiring review is the way establishments currently assess the compliance of their processing, regulated via *Meat Hygiene Assessment: Objective methods for the monitoring of processes and products.* The system of meat hygiene assessment for process monitoring is onerous both in terms of resources and costs and does not necessarily provide informative data on the efficiency of sanitation and hygiene programs. There is the view, both within industry and the Department, that the current system which has not been reviewed since 2002, would benefit from review and redrafting to accommodate changes within the industry over recent decades.

The recommendation for future research is that the meat hygiene assessment for process monitoring be reviewed and a revised system developed. Such a system has the potential to deliver reduced compliance costs and should reflect the broad change in the industry to employ risk-based inspection suitable for their business.

7. References

Kiermeier, A., Sumner, J. & Jenson, I. 2014. Risk assessment of *Escherichia coli* O157 illness from consumption of hamburgers in the United States made from Australian manufacturing beef. Risk Analysis, 35:77-89.

8. Appendix

8.1 Journal article '*Microbiological quality of Australian beef, sheep and pork carcases, cuts and offals*'

Article

Microbiological quality of Australian beef, sheep and pork carcases, cuts and offals

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Abstract: A one-year survey was undertaken of the microbiological quality of carcases and the derived primal cuts, manufacturing meat and offals at twelve Australian export establishments (six beef, three sheep/lamb, three pork). A total of 27,157 microbiological results (aerobic plate count, APC, and generic *Escherichia coli*) were gathered; 15,155 from beef, 8,405 from sheep and 3,597 from pig establishments. The mean $\log_{10}$ APC on beef, sheep and pig carcases was 0.84, 1.60 and 1.30 $\log_{10}$ cfu/cm^2, respectively. For primals, the mean $\log_{10}$ APC was higher for beef but was similar for sheep and pork primals, with 'outside' cuts having higher counts. For manufacturing meat, the concentration was 2-3 $\log_{10}$ cfu/g, irrespective of species. The prevalence (%) of generic *E. coli* from beef, sheep and pork was 2.3, 28.4 and 5.4 on carcases; 7.0, 20.6 and 3.2 on primals; and 5.8, 33.6 and 6.1 on manufacturing meat, respectively. The mean $\log_{10}$ APC of beef, sheep and pork offal was 3.23, 3.18 and 3.37 $\log_{10}$ cfu/g, with tripes and tongues having APCs 1-2 $\log_{10}$ units higher than organ offals. The results reflect improvements in total bacterial loadings compared with previous national baseline surveys.

Keywords: microbiological quality; beef; sheep; pig; carcases; cuts; offals

1. Introduction

Following several food poisoning incidents associated with the consumption of hamburgers, the Food Safety and Inspection Service in the United States introduced the *Pathogen reduction: hazard analysis and critical control point (HACCP) systems; final rule*, also known as the 'Mega Reg' [1]. As a major exporter to the USA of manufacturing meat for grinding, in 1998, Australia mandated a government-supervised monitoring program for carcases, the *E. coli* and *Salmonella* Monitoring (ESAM) program. Currently, the ESAM program is performed by all export establishments, which are required to respond to results considered unacceptable based on a three-class sampling plan and a moving window [2], the original criteria having been set using 2001 data [3]. The results are stored in a national database which is "active" with

each export establishment being able to generate reports and summaries of their data and the national, microbiological profile.

In the 25 years since the inception of mandatory monitoring, the Australian industry has undergone significant improvements in infrastructure and in process control. These changes were documented by a series of national baseline studies of beef and sheep carcases and cuts with a trend towards improved microbiological profiles of both categories [4-11]. Typically, few samples, particularly beef, had *E. coli* counts above the limit of detection, prompting establishments to question the utility of *E. coli* testing of carcases as it provided no meaningful relationship with end-product verification testing or port-of-entry testing.

This thinking, together with a parallel trend over the same period of a decrease in marketing of carcases *per se* and of increased processing of meat cuts and offals led to a review of the microbiological monitoring of Australian meat [12]. The review, undertaken with representatives from industry and the controlling authority (the Department of Agriculture, Fisheries and Forestry, DAFF), canvassed the microbiological monitoring regimes of other meat exporting countries, analysed the ESAM database and recommended an industry trial be undertaken to provide baseline data on carcases, (individually packed) primals, manufacturing or bulk packed meat and offals. Accordingly, the trial was undertaken at six beef, three sheep and three pig establishments and generated more than 20,000 data points for carcases, primals, bulk meat, and offal [13]. The resulting database provides a unique linkage between the carcase and products derived from it: bulk meat, primals and offals and is described in the present paper. In addition, it was the intention to use these data to develop alternative microbiological criteria by which to assess the performance of the Australian meat industry and to submit them for review by Australia's major trading partners.

2. Materials and Methods

2.1 Selection of establishments

Twelve establishments (six beef, three sheep and three pig) were selected from the Australian states of Queensland, New South Wales, Victoria, South Australia, Western Australia and Tasmania. An additional selection criterion was based on the size of the establishment and hence, slaughter volume; other process characteristics of each establishment are presented in Tables 1-3.

Table 1. Process characteristics of participating beef establishments.

Characteristic	**Establishment**					
	A	B	C	D	E	F
Bos taurus: Bos indicus	100:0	100:0	60:40	50:50	100:0	60:40
Feedlot, Grain-fed (%)	1	35	50	48	10	50
Slaughter volume/hour	60	70	300	100	50	125
2-knife system	No	No	Yes	Yes	Yes	Yes
Separate hide-on/hide-off areas	No	No	Yes	Yes	No	No
Bung sealed	Yes	Yes	Yes	Yes	Yes	Yes
Whole carcase intervention	No	No	Hot water	Hot water	No	No

Chilling	Air (2-4°C)	Air (2-4°C)	Spray/Air (2-4°C)	Spray/ Air (2-4°C)	Air (2-4°C)	Air (2-4°C)

Table 2. Process characteristics of participating sheep establishments.

Characteristic	Establishment		
	G	H	I
Slaughter volume/hour	480	510	600
Inverted dressing	Yes	Yes	Yes
2-knife system	Yes	No	Yes
Legging paper	Yes	No	No
Bung sealed	Yes	Yes	No
Vacuum cutting lines	Yes	Yes	Yes
Chilling	Air (2-4°C)	Air (2-4°C)	Air (2-4°C)

Table 3. Process characteristics of participating pork establishments.

Characteristic	Establishment		
	J	K	L
Slaughter volume/hour	560	260	170
Scalding	Water 60°C/6 min	Steam 8 min	Water 60°C/5 min
Bung sealed	No	No	No
Chilling	Air (2-4°C)	Air (2-4°C)	Air (2-4°C)

As indicated in Table 1, the slaughter volume/hour varied considerably across the six participating beef establishments, with two of the larger establishments, C and D, having separate hide-on and hide-off areas and a hot water intervention followed by spray chilling. A two-knife cleaning system, where one knife resides in an 82°C water bath while the other is in use, was employed by beef establishments exporting to the European Union.

Sealing of the bung with a plastic bag and elastic band was standard practice in all beef and sheep establishments, except for establishment I (Table 2) and all three pig processors (Table 3). All three sheep establishments used steam/vacuum devices to remove macro contamination on cutting lines and sheep establishments G and I operated a 2-knife system.

As indicated in Table 3, pig slaughter volumes/hour varied considerably and one processor (K) used steaming to loosen the bristles, an operation considered superior to water scalding where build-up of organic material occurs in the scald tank [14].

2.2 Sampling regime

All samples were collected over a 13-month period from October 2017 to October 2018. Carcases and bulk meat were sampled after overnight chilling according to the *Microbiological Manual for Sampling and Testing of Export Meat and Meat Products* [2] at a frequency of 1 per 300 beef carcases and 1 per 1,000 sheep or pig carcases and at the corresponding carcase equivalent rate for bulk meat. Bulk meat comprised mainly manufacturing meat (trim) destined for grinding, packed in cartons. Primals comprised cuts individually vacuum packed and chilled. Offals comprised so-called 'red' offals such as hearts and livers and 'green' offals such as tripes, which were scalded. Primals and offal were sampled at a carcase equivalent rate of 1 per 1,000 for beef and 1 per 3,000 for sheep

and pigs. Primal and offal samples were taken immediately before packing and chilling or freezing, with the exception of one pig establishment which sampled offals after chilling.

Samples were taken by quality assurance personnel at each establishment under the authorisation of the on-plant government inspection service as part of the normal ESAM program and processed at a laboratory accredited to the ISO/IEC 17025-2005 standard by the National Association of Testing Authorities, Australia. Where the laboratory was located on-site, samples were refrigerated until same-day processing. Samples transported to an off-site laboratory were refrigerated to arrive at 4°C or cooler and processed the next day.

Bacteria were removed from the carcase by back-and-forth strokes with a single Whirlpak sponge resuscitated in Butterfields solution over an area of 100 cm^2 at three sites on beef and pig carcases (limit of detection, LOD 0.08 cfu/cm^2) and 25 cm^2 at three sites on sheep carcases (LOD 0.33 cfu/cm^2) [2]. Similar methodology as for carcases was employed for primals, sponging an area of 100 cm^2 at a single site on the surface (LOD 0.25 cfu/cm^2). Excision sampling was used for bulk meat and offal samples, with approximately 25 g including some outer surface being taken (LOD 10 cfu/g).

2.3 Microbiological analysis

Testing of samples was as per the DAFF approved methods for the microbiological testing of meat and meat products [15]. For example, bacteria were removed from the sponge either by massaging sponges in a stomacher or by "squishing" sponges by hand in the sample bags for 30 seconds and, from the moisture expressed, preparing serial dilutions in 0.1% buffered peptone water blanks (9 mL) using 1 mL aliquots. Excision samples were homogenized in a stomacher with 0.1% buffered peptone to give a 10-fold dilution. Aliquots (1 mL) from each dilution were spread on *E. coli* Petrifilm (3M) and Aerobic Plate Count (APC) Petrifilm (3M) and incubated at 30°C/48h. Colonies were identified and counted as per the manufacturer's instructions.

2.3 Statistical analysis

Establishment data were sent to the South Australian Research and Development Institute either daily or weekly for entry into a database. Counts/g or cm^2 were converted to $\log_{10}$ cfu/g or cm^2 and the statistical analysis (means, analysis of variance, Tukey HSD) was carried out using the statistical software R [16] at a significance level of 0.05.

3. Results and Discussion

A total of 27,157 microbiological results were gathered as part of the trial: 15,155 from beef, 8,405 from sheep and 3,597 from pig establishments comprising 11,512 carcase, 9,872 bulk meat, 2,169 primal and 3,604 offal samples.

Box plots for APC from beef carcases, primals and bulk meat at individual beef establishments are presented in Figure 1, together with the whole industry combined, based on ESAM data, indicating that the trial establishments were broadly representative of the industry. The mean from carcases from all six establishments was 0.84 $\log_{10}$ cfu/cm^2 with establishment means ranging from 0.39 $\log_{10}$ cfu/cm^2 (Establishment F) to 1.65 $\log_{10}$ cfu/cm^2 (Establishment A). Two establishments (A and B)

had mean APC counts more than 0.5 $\log_{10}$ higher than other establishments which may reflect the fact that these establishments produced carcases slaughtered from long-haired European breeds of *B. taurus*. Industry information indicates that these cattle present challenges during rain events due to build-up of "tag", a mixture of soil and faeces on hide incision lines, the problem being magnified particularly on feedlot cattle. However, as seen from Table 1, Establishment E slaughtered similar stock at a similar line speed in the same geographical region as Establishments A and B and produced carcases with much lower APCs. At three northern establishments (C, D and F), the livestock mix contained a substantial proportion of both *B. indicus* and grain-fed cattle, which were slaughtered at line speeds of 100-300 head/hour. The low mean $\log_{10}$ APCs on carcases from these establishments are probably linked to slaughter floor interventions: Establishments C and D passed carcase sides through a hot water cabinet and at Establishment F, lactic acid was sprayed on the tail/bung area immediately after stunning. As well, industry information suggests that short-haired *B. indicus* cattle, particularly those grain-fed for 100 days, are more easily processed on the slaughter floor because the fat layer beneath the hide facilities its removal. However, during the northern raining season, feedlot cattle enter abattoirs with a considerable amount of soil and faecal contamination of the hide, as do European breeds in the southern states. Establishments C and D also differed from other beef establishments by using spray chilling to offset the weight loss which accompanies air chilling. After overnight chilling, passage of beef carcases through the boning room resulted in higher mean APCs of 0.4-1.3 $\log_{10}$ cfu/cm^2 for primals; bulk meat APCs were also higher, although their comparison with carcases and primals are not possible because counts were obtained by excision sampling ($\log_{10}$ cfu/g).

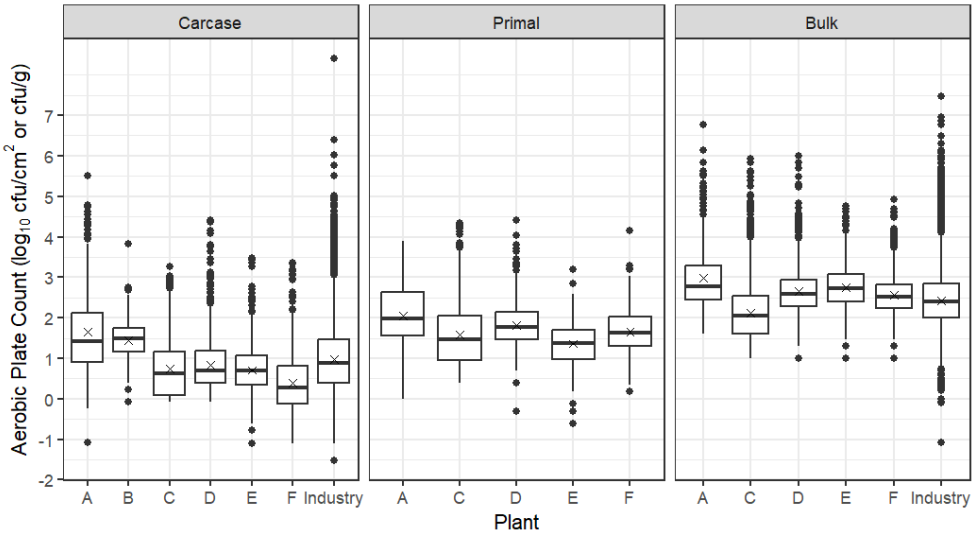

Figure 1. Box plots of the APC of beef carcases ($\log_{10}$ cfu/cm^2), primals ($\log_{10}$ cfu/cm^2) and bulk meat ($\log_{10}$ cfu/g) from Establishments A-F. The box encompasses data between the 25th and 75th percentiles, with the mean indicated by 'X' and median by a solid line. Box plots of the whole industry (ESAM data including trial establishments) are also given for carcases and bulk meat.

While the prevalence of *E. coli* on beef carcases was generally low, there were more frequent detections at each establishment after fabrication to bulk meat and primals (Table 4). While concentrations remained low on primal meat, higher concentrations were detected from bulk product, possibly because bulk meat has a higher proportion of trim from external carcase surfaces.

Table 4. Prevalence (%) and (mean $\log_{10}$ concentration*) of *E. coli* on carcases ($\log_{10}$ cfu/cm^2), primals ($\log_{10}$ cfu/cm^2) and bulk meat ($\log_{10}$ cfu/g) at beef establishments A-F. Mean values with the same letter within the same column are not significantly different.

Establishment	Carcase	Primal	Bulk
A	1.7 (-0.57^a)	6.8 (-0.19^a)	4.5 (1.13^a)
B	2.7 (-0.97^a)	-	-
C	0.7 (-1.06^a)	9.5 (-0.29^a)	1.9 (1.29^a)
D	3.7 (-0.79^a)	7.0 (-0.03^a)	9.2 (1.49^a)
E	5.5 (-0.86^a)	6.5 (-0.17^a)	11.2 (1.30^a)
F	1.1 (-0.89^a)	3.5 (-1.18^b)	4.7 (1.39^a)
Whole of industry	2.7 (-0.64^a)	-	-

* cfu/cm^2 or cfu/g of detections

With respect to primal cuts, the mean $\log_{10}$ APC of primals from the five beef establishments was 1.65 $\log_{10}$ cfu/cm^2 with means for specific primals ranging from 1.41 and 1.42 $\log_{10}$ cfu/cm^2 on internal cuts, such as tenderloins and cube rolls, to 1.80 to 1.99 $\log_{10}$ cfu/cm^2 on cuts with external surfaces such as outside, brisket and blade; not unexpectedly, the prevalence of *E. coli* was also higher on external cuts (Table 5).

Table 5. APC of beef primals (log_{10} cfu/cm^2) and *E. coli* prevalence (%) at participating beef establishments. Mean values with the same letter are not significantly different.

Primal	n	Mean log_{10} cfu/cm^2	*E. coli* prevalence (%)
Tenderloin	105	1.41^{a}	1.9
Cube roll	106	1.42^{a}	6.6
Striploin	109	1.43^{ab}	6.4
Chuck	73	1.52^{abc}	2.7
Chuck tender	86	1.60^{abc}	7.0
Eye round	85	1.63^{abc}	8.2
Rump	94	1.66^{abcd}	6.4
Navel end brisket	83	1.68^{abcd}	8.4
Topside	85	1.77^{bcd}	7.1
Knuckle	116	1.78^{cd}	8.6
Outside	90	1.80^{cd}	11.1
Point end brisket	84	1.85^{cd}	6.0
Blade	94	1.99^{d}	10.6

Box plots for APC from carcases, primals and bulk meat at individual sheep establishments are presented in Figure 2, together with the whole industry combined, based on ESAM data, indicating that the trial establishments were broadly representative of the industry. The mean log_{10} APC from carcases across all three sheep establishments was 1.56 log_{10} cfu/cm^2 with Establishment H having a mean around 1 log_{10} units higher than Establishments G and I. All three sheep establishments used inverted dressing, but line speed differed from 8/minute (Establishment G) to 8.5 (Establishment H) and 10 (Establishment I), as did the use of a two-knife system and legging paper to prevent roll-back of the pelt and consequent contamination of the forequarters (Table 2).

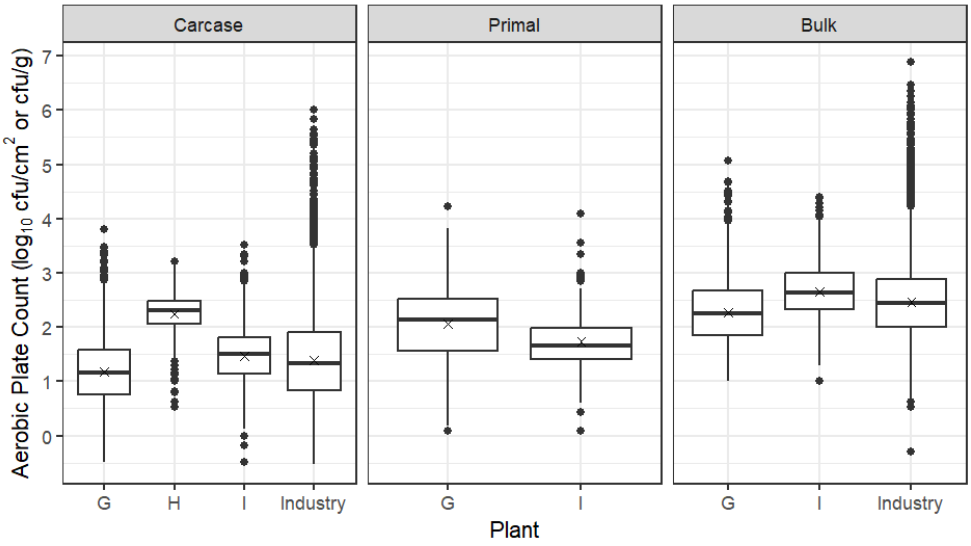

Figure 2. Box plots of the APC of sheep carcases (log_{10} cfu/cm^2), primals (log_{10} cfu/cm^2) and bulk meat (log_{10} cfu/g) from Establishments G-I.

After overnight chilling and passage of sheep carcases through the boning room, the mean log_{10} APC of primals was around 1 log_{10} cfu/cm^2 higher at Establishment G and less than 0.5 log_{10} cfu/cm^2 higher at

Establishment I; bulk meat mean $\log_{10}$ APCs at Establishment G and I were 2.27 and 2.66 $\log_{10}$ cfu/g, respectively. All carcases from Establishment H were shipped offsite for fabrication at independent boning rooms; hence the absence of data for primals and bulk meat.

Following boning, the detection of *E. coli* was higher on sheep primals, compared with carcases, with the average concentration of *E. coli* from positive samples of carcases and primals ≤ 0.1 $\log_{10}$ cfu/cm^2 (2 cfu/cm^2). On excised samples of bulk meat, the prevalence of *E. coli* ranged from 15-24%, with the average concentrations ≥ 1.3 $\log_{10}$ cfu/g (20 cfu/g) at sheep establishments G and I (Table 6).

Table 6. Prevalence (%) and (mean $\log_{10}$ concentration*) of *E. coli* on carcases ($\log_{10}$ cfu/cm^2), primals ($\log_{10}$ cfu/cm^2) and bulk meat ($\log_{10}$ cfu/g) at sheep establishments G-I. Mean values with the same letter within the same column are not significantly different.

Establishment	Carcase	Primal	Bulk
G	30.9 (0.1^a)	38.4 (-0.06^a)	15.8 (1.30^a)
H	35.3 (-0.07^b)	-	-
I	22.7 (-0.08^b)	28.7 (-0.15^a)	24.0 (1.38^a)
Whole of industry	13.1 (-0.04)	-	-

* cfu/cm^2 or cfu/g of detections

The mean $\log_{10}$ APC of primals from the two sheep establishments was 1.89 $\log_{10}$ cfu/cm^2 with means for individual primals close to the overall mean. The prevalence of *E. coli* was much higher than on beef primals, especially on legs and shoulders (Table 7).

Table 7. APC of sheep primals ($\log_{10}$ cfu/cm^2) and *E. coli* prevalence (%) at Establishments G and I. Mean values with the same letter are not significantly different.

Primal	n	Mean $\log_{10}$ cfu/cm^2	*E. coli* prevalence (%)
Short loin	39	1.68^a	25.6
Tenderloin	23	1.71^a	26.1
Loin	51	1.78^a	21.6
Leg bone in	66	1.80^a	43.9
Rack	108	1.89^a	16.7
Shoulder bone out	21	1.89^a	23.8
Leg bone out	59	1.91^a	47.5
Shank	27	1.91^a	29.6
Square cut shoulder	79	1.94^a	38.0

As for beef and sheep, box plots for APC from carcases, primals and bulk meat at individual pork establishments are presented in Figure 3, together with the whole industry combined, based on ESAM data, indicating that the trial establishments were broadly representative of the industry. The mean $\log_{10}$ APCs from carcases from all three pork establishments was 1.35 $\log_{10}$ cfu/cm^2, with the average being 1 $\log_{10}$ cfu/cm^2 higher at pork establishment J, compared with establishments K and L, possibly related to its faster line speed. Steam scalding at Establishment K may also be linked with its lower APC. After overnight chilling and passage of pig carcases through the boning room, the mean $\log_{10}$ APCs of primals was higher at Establishments K and L but lower at

Establishment J; bulk meat mean APCs ranged between 2.5 and 3.0 $\log_{10}$ cfu/g.

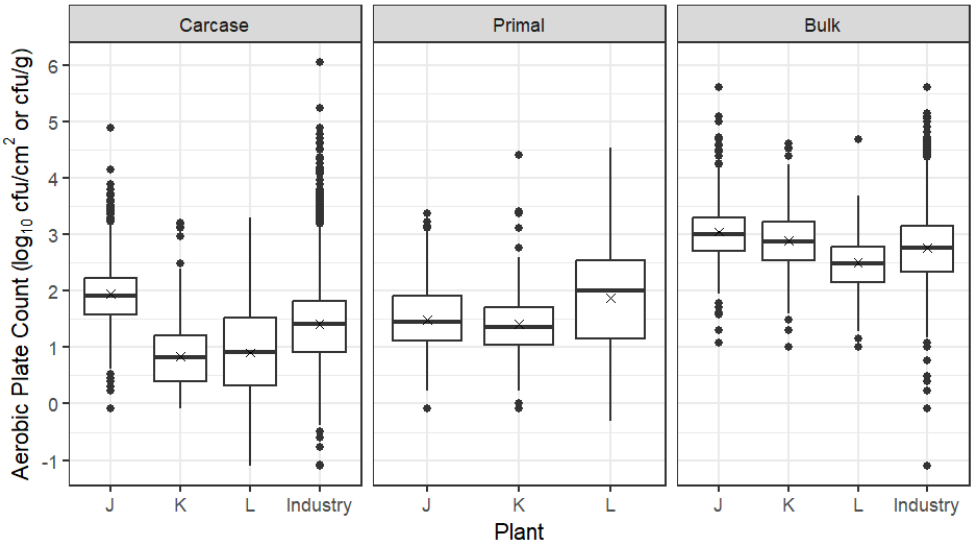

Figure 3. Box plots of the APC of pork carcases ($\log_{10}$ cfu/cm^2), primals ($\log_{10}$ cfu/cm^2) and bulk meat ($\log_{10}$ cfu/g) from Establishments J-L.

Following boning, the prevalence of *E. coli* was lower on pork primals, compared with carcases. On excised samples of bulk meat, the prevalence of *E. coli* ranged from 1.4-3.9%, with the average concentrations approximately 1.2 $\log_{10}$ cfu/g (16 cfu/g) (Table 8).

Table 8. Prevalence (%) and (mean $\log_{10}$ concentration*) of *E. coli* on carcases ($\log_{10}$ cfu/cm^2), primals ($\log_{10}$ cfu/cm^2) and bulk meat ($\log_{10}$ cfu/g) at pig establishments J-L. Mean values with the same letter within the same column are not significantly different.

Establishment	Carcase	Primal	Bulk
J	5.0 (0.27^a)	3.8 (-1.07^a)	3.9 (1.21^a)
K	5.9 (-0.09^b)	3.4 (-0.92^a)	1.4 (1.23^a)
L	5.4 (-0.02^c)	2.1 (1.00^b)	-
Whole of industry	3.8 (-0.50)	-	-

* cfu/cm^2 or cfu/g of detections

The mean $\log_{10}$ APC of primals from the three pork establishments was 1.57 $\log_{10}$ cfu/cm^2 with means for individual primal cuts similar to the overall mean, with the exception of trotters, which were considerably higher than other primals (Table 9).

Table 9. APC of pork primals (log_{10} cfu/cm^2) at Establishments J-L. Mean values with the same letter are not significantly different.

Primal	n	Mean log_{10} cfu/cm^2
Tenderloin	32	1.32^{a}
Ribs	33	1.34^{a}
Belly	40	1.40^{a}
Loin	28	1.44^{a}
Middle	24	1.49^{a}
Leg	36	1.55^{a}
Shoulder	32	1.55^{a}
Topside	20	1.61^{ab}
Collar butt	25	1.66^{ab}
Trotter	32	2.38^{b}

Establishments reported APCs for more than 40 offal types, of which the most commonly collected (n>25) are presented in Table 10. All establishments collected 'red' offals (hearts, kidneys, livers, etc.) while 'green' offals (stomach parts processed by scalding) were collected predominately from beef and sheep. Some offals were specific for only sheep (brains) or pigs (chitterlings, ears, snouts, trotters).

Table 10. Mean log_{10} APC (log_{10} cfu/g) of beef, sheep and pig offals. Mean values with the same letter within the same column are not significantly different.

Offal	Beef		Sheep		Pig	
	n	Mean	n	Mean	n	Mean
Aorta	29	1.82^{a}	-	-	-	-
Diaphragm	27	1.95^{a}	-	-	-	-
Tendon	28	2.60^{abc}	-	-	-	-
Omasum	113	2.79^{b}	-	-	-	-
Liver	146	2.84^{b}	230	2.96^{a}	38	2.37^{a}
Kidney	100	2.90^{bc}	258	2.90^{a}	38	2.50^{a}
Honeycomb	135	2.92^{bc}	-	-	-	-
Heart	143	2.94^{bc}	239	2.79^{a}	30	2.26^{a}
Tripe pieces	104	3.15^{bcde}	307	3.69^{c}	-	-
Skirt	285	3.18^{cd}	84	3.33^{b}	-	-
Tail	121	3.56^{ef}	29	3.64^{bc}	-	-
Mountain chain	84	3.57^{defg}	-	-	-	-
Head meat	241	3.74^{fg}	-	-	-	-
Tongue	209	3.98^{g}	45	4.48^{d}	60	4.49^{c}
Brain	-	-	30	3.58^{bc}		
Trotter	-	-	-	-	31	3.61^{b}
Snout	-	-	-	-	33	3.78^{b}
Ear	-	-	-	-	36	3.90^{b}
Chitterling	-	-	-	-	26	4.59^{c}
All combined		3.23		3.18		3.37

While microbiological quality varied between offal type, there was comparably little variability between the same offals taken from beef, sheep or pig carcases. Offal from organs (heart, liver and kidney) were generally 2 log_{10} cfu/g while tripes were 3 log_{10} cfu/g and tongues were 4 log_{10} cfu/g. It might be expected that organ offals could be removed

without significantly increasing their bacterial load, and so would pick up contamination whilst passing down chutes and from handling in the offal room. In contrast, offals derived from the gastrointestinal tract would have a high bacterial loading prior to washing, scalding and cooling, a proportion of which would be retained on the finished product. Tongues and meats derived from the head might also be expected to have a higher bacterial loading, stemming from contamination with saliva. The mean APCs in Table 10 are very similar to those obtained in a contemporaneous survey of chilled and frozen offals from 17 Australian export establishments which stated "the average APC on beef, sheep and lamb offal was 3.25, 3.38 and 3.70 $\log_{10}$ cfu/g, respectively" [17].

Previous surveys [4-11] monitored carcases and cuts at establishments which represented approximately 80% of industry output. By contrast, the present 13-month survey monitored establishments representing approximately 26% (beef), 15% (sheep) and 41% (pork) of national output on a daily basis. As well, the present survey sampled carcases plus products derived from them: primal cuts, bulk meat and offals; for carcases and the derived end products; there was little evidence of seasonal effects on APCs [13].

In Table 11 are presented summary data of surveys of Australian beef and sheep carcases, which all used the same methodology. As a result, it may be construed that there has been a meaningful reduction in total bacterial loadings over the period 1998-2018, reflecting significant improvements in livestock handling, establishment infrastructure, operator training and the uptake of HACCP systems throughout the industry.

Table 11. Beef and sheep carcase contamination in Australia from 1998-2018.

	n	Mean APC ($\log_{10}$ cfu/cm^2)	Reference
Beef*			
1998	1,268	2.4	[6]
2004	1,147	1.3	[8]
2018	6,016	0.8	Present study
Sheep**			
1998	917	3.5	[7]
2004	1,117	2.3	[9]
2018	3,693	1.6	Present study

*LOD 0.08 cfu/cm^2

**LOD 0.33 cfu/cm^2

Currently, the performance of individual establishments is assessed against criteria set by the Australian regulator, the Department of Agriculture, Fisheries and Forestry (current name) in the *Microbiological Manual for Sampling and Testing of Export Meat and Meat Products* [2], using limits for APC and generic *E. coli* and 3-class sampling plans that are assessed on a moving window of consecutive samples (n=15), as described by FAO/WHO [18]. A window failure occurs when the number of marginal results (> m but ≤ M) exceeds c, or a single result exceeds the unacceptable level (M); there are different values for c, m and M according to livestock category [2]. In the present survey, there were 19 failed windows in five establishments over the 13-month survey period – 13 for beef, five for sheep and one for pig carcases (Table 12). No other establishment had a moving window failure.

Table 12. Failed windows for APC and *E. coli* on beef, sheep and pig carcases; in the 'm' column are listed the number of failures due to exceeding 'm' too many times in the moving window, while in the 'M' column are listed the number of failures due to exceeding 'M'.

Establishment	APC failed windows		*E. coli* failed windows	
	m	M	m	M
A	6	5	0	0
D	0	0	1	0
E	0	0	1	0
G	0	0	0	5
J	0	1	0	0

As set out by DAFF [2], Australia's current performance monitoring system sets different sampling and evaluation criteria for carcases of bovines, ovines, porcines, caprines, cervines, equines, *Camelidae*, ratites, macropods and wild boars, and for various categories within them (steer/heifers versus cow/bulls). For the three most processed species (bovines, ovines and porcines), the criteria for n, c, m and M were formulated based on performance data from 2001-2002 [3]. However, as indicated in Table 11, the hygienic condition of carcases has improved greatly over the ensuing period and the export of carcase parts, particularly primals and offals, has also increased substantially, e.g. offal exports now exceed 200,000t/annum [19].

The results of this trial have enabled representatives from industry, the regulator and research establishments to develop criteria which better reflect the performance of the current meat industry. Major proposed changes include setting identical criteria for n, c and an m-limit for products (carcases, primals, bulk meat and offals) from all species (beef, sheep, pork, etc.); removing *Salmonella* testing; reducing frequency of carcase monitoring balanced by monitoring primals, bulk meat and offals. The window system is retained and failure to meet any criterion for any product triggers an Alert requiring the establishment to review the process to identify any factors that may have caused the Alert and take any corrective and preventative action to control those factors in discussion with the on-plant veterinarian.

The resultant alternative monitoring system is currently being reviewed by Australia's major trading partners.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy obligations to the participating processing establishments.

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Conflicts of Interest: Author Andreas Kiermeier was employed by the company Statistical Process Improvement Consulting and Training Pty Ltd. Author John Sumner was employed by the company M&S Food Consultants Pty Ltd.

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disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

8.2 Brochure '*Modernising the Australian meat industry – big changes coming soon to MHA Product Monitoring*'

Modernising the Australian meat industry - big changes coming soon to MHA Product Monitoring

In recent years, AMPC has funded several industry trials to modernise the way we monitor and test meat products. Together with scientists at the South Australian Research and Development Institute (SARDI), we have worked with the Department of Agriculture, Fisheries and Forestry to:

1. Reduce the number of KPIs processors need to include in monthly PHI reporting and abolish the traffic light system.
2. Develop an improved risk-based microbiological testing regime, which the Department is currently discussing with their counterparts in major importing countries.
3. Develop a new system of visual monitoring for product (MHA 3 Product Monitoring), which the Department will introduce in 2023.

A new MHA 3 Product Monitoring system

In 2021, SARDI concluded an industry trial involving six beef, three sheep and three pork plants to trial the new MHA 3 system of visual monitoring for product. These plants sent their daily monitoring data to SARDI for analysis. The trial was successful, and all trial plants are continuing with MHA 3.

The Department is now working towards transitioning all Tier 2 export establishments to the new MHA 3 Product Monitoring system and AMPC has commissioned SARDI to assist plants in the transition.

MHA 3 – main points

1. The focus is on food safety, based on Zero Tolerance (ZT), pathology and contamination-related defects.
2. Non-food safety (minor and manufacturing) defects are removed.
3. Pre-boning room inspection checks are retained.
4. ZTs and pathology are retained as per current definition.
5. Risk-based ratings to individual primal and offal products are made, which has a big effect on frequency of monitoring.
   - High risk products are monitored every hour by examining a whole carton.
   - Low risk products are monitored less often.

How we will assist

To move from MHA 2 to MHA 3 requirements, all plants will need to make changes to your Approved Arrangement, based on the risk-ratings developed from your historical MHA 2 data.

Step 1: SARDI is developing a 'How-To Guide' which will show you how to implement MHA 3 Product Monitoring into your system. The guide will be provided to you in the next few weeks.

Step 2: To assist you further, AMPC and SARDI are scheduling three interactive sessions in February and March, where we will run through the risk assessment process. All the sessions will be the same and should you wish to attend, you will be asked to nominate your preferences for attendance. Numbers will be limited for each session.

8.3 How-To Guide

Meat Hygiene Assessment Product Monitoring 3rd Edition (MHA 3)

How to amend your Approved Arrangement (AA)

February 2023

Contents

Modernisation of the Australian Meat Industry

Over recent years, the South Australian Research and Development Institute (SARDI) has been funded by the Australian Meat Processor Corporation (AMPC) to improve the ways in which the Australian meat industry monitors the microbiological and visual condition of its products.

Working closely with industry and the Department of Agriculture, Fisheries and Forestry (DAFF), we reduced significantly the number of Key Performance Indicators which industry are measured by each month and developed a new microbiological testing system, which is currently being assessed by regulators in the USA, EU and UK.

In addition, we trialled alternative monitoring procedures with twelve export establishments (six bovine, three ovine and three porcine) selected from every state of Australia. The project gathered a massive database: 27,157 microbiological results and 1,645,537 visual checks. We analysed these data and with industry and DAFF, developed *Meat Hygiene Assessment: Product Monitoring* (3rd edition).

Now known as MHA 3 Product Monitoring, the system focuses on food safety (Zero Tolerance, pathology and contamination-related defects), removes minor and non-food safety (Manufacturing) defects and monitors individual products based on how an establishment assesses their risks.

Eleven establishments trialled the new system and, in 2022, DAFF approved its routine use and began changing their own management, reporting and recording systems to accommodate the change-over to MHA 3 later this year.

Main features of MHA 3

There are several key changes to the way you will monitor under MHA 3, which we list here.

Later, we step you through these changes in detail as they apply to carcases, carton meat and offals.

Change 1: Only food safety defects are recorded

You now need record only Zero Tolerance (ZT) defects, pathology defects and contamination-related criteria that were previously considered to be Major or Critical defects as part of MHA 2. Previous Minor defects are no longer scored.

Change 2: The Marginal category is eliminated

From now on, product lots are rated as either Acceptable or Not Acceptable.

Change 3: Defect rating calculations and limits of acceptability are changed

Carcases, carton meat and offals have new limits of acceptability based on a simplified Defect Rating.

Change 4: Reduced/intensified sampling frequency is eliminated

The concept was considered counter-productive and was therefore removed.

Change 5: Classification of each product according to risk

Monitoring is now carried out according to the risk rating you give to each carton meat and offal product.

Change 6: Frequency of monitoring of carton meats and offals

The risk rating you give to each product will determine how frequently you monitor it – high risk products are monitored more frequently than low risk.

Change 7: Quantity of carton meat monitored

All product in the carton is monitored.

Change 8: Quantity of offal monitored

A lot of 12 offal pieces is monitored throughout the lot.

Change 9: Corrective action

There are requirements for immediate corrective action for product still on the slaughter floor and in the boning and offal rooms and for product which has been packed and is undergoing temperature reduction.

What you need to do

Amend your work instructions to incorporate the above changes, especially the risk assessments of carton meat and offals, which will significantly change the way you monitor.

You also need to develop immediate corrective actions and be able to recover product which needs reinspection and clearance.

To assist you in amending your Approved Arrangement, AMPC has commissioned SARDI to develop this How-to guide and to deliver three webinars in February and March where we will field your questions.

Assessment of carcases, sides and quarters

There are significant changes for you to implement in your AA.

1. Sampling plan

Sample numbers are the same as MHA 2 but there is no longer any reduced or intensive sampling – just the normal level (Table 1).

In addition, the definition of a "lot" remains unchanged.

Table 1: Sample Numbers

Number of animals in a lot	Sample size
1 - 25	5
26 – 50	8
51 - 90	13
91 - 280	20
281 – 500	32
> 500	50

2. Carcase contamination defects

Defects now include only Zero Tolerance (ZT) defects, pathology defects and contamination-related criteria that were previously considered to be Major or Critical defects as part of MHA 2. Minor defects are not monitored or included in the defect rating since these were categorised as: *"Affects appearance; not food safety"* in MHA 2. In addition, no distinction is made between Major and Critical defects.

In MHA 3, defects are classified to reflect their effect on the safety and suitability (wholesomeness) of the product (Table 2).

Table 2: Classification of carcase contamination defects

Defect criterion	Detection of a likely food safety relevant defect	Zero Tolerance
Faeces, Milk, Ingesta Contamination		Any Amount[1]
- Urine	Any Amount	
- Rail Dust, Specks, Hide & Wool Dust	≥ 11	
- Smears & Stains (inc bile, oil & grease)	≥ 1 cm diameter	
- Hair & Wool Strands[2]	≥ 11	
- Hair & Wool Clusters, Hide, scurf, toenails[2]	≥ 2 Hide ≥ 1 cm gross diameter (GD)	
- Foreign objects	Any non-animal material	
Pathology[3]	Any	

1. Retained lactating udder fragments are evidence of milk contamination. Gut segments, including oesophagus, are classified with faeces, ingesta and milk.

For a defect to be rated as a zero tolerance defect it must be clearly identifiable to the naked eye as faeces, ingesta or milk.

2. Short attached shaved bristles on pigs and skin-on goats are exempt as hairs.

3. Abscesses are classified as pathology.

Zero tolerance detection on carcases selected for monitoring after the final trim automatically rates the lot as unacceptable. The affected lot is subject to further investigation and corrective action as described in the section on Corrective Action.

3. Recording

You need to record the assessment of samples in the appropriate columns on a recording sheet by inserting the result for multiple carcases/sides in each column (see Appendices for examples), or by entering the results directly into your electronic recording system. Other details such as the plant identifier; species; date and time of sample checking; name, position and signature of the person undertaking the check should also be recorded (Appendix 1-5).

Note that non-scoring defects for carcases and sides are not cumulative over the lot and you must trim and remove them.

4. Limit of acceptability and calculating the defect rating

Any detection of a zero tolerance defect during sampling automatically rates the lot as unacceptable. If a ZT has been detected, then no Defect Rating needs to be calculated.

Where no ZTs are detected, the Defect Rating is calculated as the total number of defects (as per Table 2) divided by the number of samples.

The limit of acceptability has been revised to 0.25, which is equivalent to MHA 2.

The “lot”, as defined by you, is categorised as in Table 3 based on the defect ratings determined on product before it leaves the slaughter floor.

Table 3: Defect rating limits for carcases/sides before they leave the slaughter floor.

Defect rating	Rating
≤ 0.25	Acceptable
> 0.25	Unacceptable

Here is an example of how to calculate a carcase defect score.

Defect criterion	Number of Detections
Contamination	3
Pathology	1
Total number of Defects	3+1=4
Number of checks	50

The Defect Rating is the total number of contamination and pathology defects divided by the number of checks = (3+1) / 50 = 0.08.

5. Corrective action

1. Corrective action must address both immediate (for the affected lot) and the longer term preventative measures.
2. Immediate corrective action is required with unacceptable product and zero tolerance findings.
3. The work instruction for corrective action must be contained in the Approved Arrangement.
4. The corrective action must be recorded, the effectiveness of the action verified and the verification recorded.

Immediate corrective action

1. Trim all defects immediately.
2. Where zero tolerance is identified, include a review and correction of the process controls and attention by slaughter floor trimmers to the problem area.
3. Undertake additional trim on all related product (carcases/sides in the monitoring lot) in the failed lot.
4. Where product is boned by the same establishment, intensify the pre-boning trim by placing special emphasis on identified problem areas, according to the established program agreed between the company and DAFF.
5. Verify the effectiveness of this trim by sampling and record the results.
6. Record the cause of the defects and how you have corrected this.

MHA for Pre-Boning Room Inspection

1. Examine at least 10 carcases/sides per lot to assess the effectiveness of the trim using the same defect criteria in Table 2.
2. The definition of a lot is unchanged from MHA 2 and is determined by you.
3. Select samples randomly and spread them over the lot.
4. The acceptable defect rating is ≤ 0.1 and you calculate this by dividing the total number of defects (as per Table 2) by the number of samples.

5. Defects identified during inspection should be removed immediately and the entire lot represented by the sample gets any corrective action needed.
6. A zero tolerance detection on carcases selected for monitoring after the pre-boning trim, automatically rates this lot as unacceptable. It also triggers immediate corrective action in the form of increased monitoring and adjustment of the operation.
7. The affected lot is subject to further investigation and corrective action as described in the above section on Corrective Action.

Assessment of carton meat

Your task is to ensure that each carton of boneless manufacturing meat and bulk and layer packs leaves the boning room free of ZTs and food safety-relevant defects and there are significant changes from the procedures you used under MHA 2.

1. Monitoring according to product risk

You need to sort your products into two categories based on risk: high risk and low risk. You do this by checking the monitoring data to assess the performance of each product's inspection results **over the past six months** – and here is an example of how to do it.

Product	Number of checks	Contamination defects*	Pathology	Total	Prevalence
Trim 60CL	420	0	0	0	0%
Trim 80CL	518	0	0	0	0%
Trim 90CL	345	1	0	1	0.28%
Bolar	712	0	0	0	0%
Inside	867	8	0	9	0.9%
Flank	698	0	0	0	0%

*as defined in Table 4

Based on the above, you might put Insides on your High risk list and all the rest on a Low risk list. You might also consider grouping all Trim types into one line for monitoring purposes and, on the basis of one defect in more than 1200 samples, you could justify allocating Trim to the Low risk category.

But you should also consider commercial risk and take into account the following factors:

- Market and customer requirements
- Customer complaints/advice
- Port of entry detections
- Knowledge about the type of product and degree of processing (for example, denuded products and those without external carcase surfaces might be considered Low risk).

For example, despite the above inspection result, suppose you had several customer complaints about Flanks. In this case, Flanks could also be classified as High risk.

Once you have identified all your High risk products, the remainder automatically go into the Low risk category. You must be able to justify your decisions on risk and provide supporting data and information. This classification process will be verified by the Department and both Low and High risk products may be sampled as part of their verification process.

2. Sampling plan and monitoring frequency for High risk products

1. You need to draw one full carton of **each High risk product** every 60 minutes.
2. Sample only when the product is being produced – do not include breaks when you calculate the 60-minute sampling interval.
3. You need to assess the whole carton (not half the carton as in MHA 2) following completion of carton packing.

3. Sampling plan and monitoring frequency for Low risk products

1. You need to draw one carton from the **entire Low risk category** every 60 minutes.
2. Sample only when the product is being produced – do not include breaks when you calculate the 60-minute sampling interval.
3. You need to assess the whole carton (not half the carton as in MHA 2) following completion of carton packing.
4. At any one sampling time, only assess a whole carton of **one** of the Low risk products (e.g. 60CL Trim); at the next sampling time assess a different product. Over time, you must cycle through all the products in the Low risk group.

4. Sampling combo bins

If you pack combo bins, you determine the mass sampled and the intervals between sampling, but these should be at a comparable amount/frequency of product packed in cartons.

5. Product contamination defects

In MHA 3, defects of carton meats are related to the safety and suitability (wholesomeness) of the product (Table 4).

As for carcases, no distinction is made between what used to be Major and Critical defects.

Table 4: Classification of carton meat defects

	Detection of a likely food safety relevant defect	Zero Tolerance
Faeces, milk, ingesta		Any Amount
Contamination - Rail dust, specks, hide & wool dust - Stains, discoloured areas - Hair, wool, hide - Foreign objects	 ≥ 11 1× > 4cm GD or More than 5× 1-4 cm GD ≥ 11 strands Hide > 1cm diameter Any non-animal material	
Pathological lesions	Any lesion including inflamed seeds	

Criteria for defect classifications refer to totals recorded in a sample from one carton.

6. Recording, limit of acceptability and calculating the defect rating

You need a trained and competent employee assigned as a boning room quality control inspector to conduct and record these inspections in real time.

1. Record monitoring data separately for each product in the High risk category and for the Low risk products as a group.
2. Record the product type sampled and the time of sampling.
3. For each sample, record the number of defects on the control form (Appendix 2 and 3) according to the defect classification above (Table 4).
4. Product is deemed acceptable if no ZTs are detected or not more than 1 defect per product type or Low risk group in a shift.

5. Defects are not accumulated and tracked back over shifts/days, as in MHA 2. Each day stands on its own.

7. Corrective action

1. Corrective action must address both immediate (for affected product) and the longer term preventative measures for ZT affected product or an unacceptable defect rating.
2. Immediate corrective action is required for unacceptable product.
3. The work instruction for corrective action must be contained in the Approved Arrangement.
4. The corrective action must be recorded, its effectiveness verified and the verification recorded.

Immediate corrective action

1. For High risk products, you need to re-inspect all available meat in the boning room associated with the product type from which the defect has been detected and trim any defects.
2. For Low risk products, you need to re-inspect all contributing product types and trim any defects.
3. After you have re-inspected all product in the room and find no defects according to the classification in Table 4, no further action is required.
4. If you do find one or more defects according to the classification in Table 4, the offending product (back to the last clear check) is subjected to re-inspection.
   a) If possible, re-inspect product that has not entered the freezer, otherwise you will need to withdraw frozen product and thaw for re-inspection.
   b) Randomly select 6 cartons and remove 5.5 kg samples from each.
   c) Assess the selected samples according to the classification in Table 4.
   d) If you still find 1 or more defects in these 6 cartons, re-inspect and rework all affected product so it is acceptable and fit for human consumption.
      a. All meat pieces with a ZT in a fresh meat pack shall be rejected as unsuitable for human consumption unless restored by employing the program approved for dropped meat.
      b. Where a ZT is detected in a thawed meat pack, the entire pack shall be rejected for human consumption.
5. All non ZT defects identified are to be trimmed and removed.

Assessment of offals

Your task is to ensure offals leave the offal packing room free of ZTs and food safety relevant defects after assessment by trained operators. Offals (excluding green offals) are assessed following final processing.

1. Monitoring according to product risk

In exactly the same way that you assessed risk of carton meats, you need to group offals into two categories based on risk: High risk and Low risk.

You do this by checking the monitoring data to assess the performance of each product's inspection results **over the past six months** – and here is an example of how to do it.

Offal Type	Number of checks	Contamination defects*	Pathology	Total	Prevalence
Heart	6140	0	0	0	0%
Kidney	3620	0	0	0	0%
Liver	6160	0	1	1	0.02%
Spleen	10	0	0	0	0%
Tripe	6090	20	0	20	0.3%
Lips	5982	0	0	0	0%

*as defined in Table 5

Based on these results, you might decide to classify as High risk all products with a prevalence > 0% (at least on defect detection) or perhaps only classify Tripe as it had repeat defects, even though the prevalence is quite low. The decision of where to draw the limit is yours, but you will need to discuss and agree this with the Department.

But you should also consider commercial risk and take into account the following factors:

- Market and customer requirements.
- Customer complaints/advice
- Port of entry detections
- Knowledge about the type of product and degree of processing for example, you might include Lips as High risk because of the way one of your customers uses head offals.

Once you have identified all your High risk products, the remainder automatically go into the Low risk category. You must be able to justify your decisions on risk and provide supporting data and information. This classification process will be verified by the Department and both Low and High risk products may be sampled as part of their verification process.

2. Sampling plan and monitoring frequency for High risk products

For each High risk offal, your sample size is 12 pieces of offal selected at random and assessed for every lot. The aim should be to select samples on at least three different times during each lot. The definition of a "lot" is unchanged from MHA 2 and is determined by you.

3. Sampling plan and monitoring frequency for Low risk products

For the Low risk group, assess 12 offal pieces of one type from the whole lot.

Select offals so that you cycle through all the products in the Low-risk group over time.

4. Offal contamination defects

In MHA 3, defects of offals are related to the safety and suitability (wholesomeness) of the product (Table 5).

Table 5: Classification of offal defects

	Detection of a likely food safety relevant defect	Zero Tolerance
Faeces, milk, ingesta		Any Amount[1]
Contamination - Smears & stains (inc bile, oil & grease) - Hair & Wool Strands - Hair & Wool Clusters - Foreign objects	 ≥ 1 cm (GD) ≥ 11 ≥ 2 Any non-animal material	
Pathology[2]	Any incidence	

[1] Gut segments, including oesophagus, are classified along with faeces, ingesta and milk.

[2] Urine retention cysts are considered pathology.

5. Recording, limit of acceptability and calculating the defect rating

You need a trained and competent employee assigned as an offal room quality control inspector to conduct and record these inspections in real time.

1. Record monitoring data separately for each offal in the High risk category and for the Low risk products as a group.
2. Record the offal type sampled and the time of sampling.
3. For each sample, record the number of defects on the control form (Appendix 4 and 5) according to the defect classification above (Table 5).
4. Any detection of a Zero Tolerance defect during sampling will automatically rate the lot as unacceptable. If a ZT has been detected, then no Defect Rating needs to be calculated.
5. To calculate the Defect Rating for the lot, you divide the total number of defects by the sample number (12).
6. You're allowed one defect/sample group (1/12=0.083).
7. The defect rating is categorised as in Table 6.

Table 6: Defect rating limits for a lot of offal from all species

Defect rating	Lot Rating
< 0.084	Acceptable
≥ 0.084	Unacceptable

6. Corrective action

1. Corrective action must address both immediate (for ZT affected project) and the longer term preventative measures for ZT affected product or an unacceptable defect rating.
2. Immediate corrective action is required for unacceptable project.
3. The work instruction for corrective action must be contained in the Approved Arrangement.
4. The corrective action must be recorded, its effectiveness verified and the verification recorded.

Immediate corrective action

1. All defects shall be trimmed immediately.
2. Where zero tolerance is identified, corrective action shall include re-inspection of all available offal in the room associated with the finished offal type; trim any defects.
3. After you have re-inspected all product in the room and find no defects according to the classification in Table 5, no further action is required.
4. If you find one or more defects according to the classification in Table 5, you need to re-inspect the offending product back to the last clear check.
    1. Assess the selected cartons on the basis of the classification in Table 5.
    2. Any unacceptable product must be re-worked with an additional trim and re-inspected until all affected product is rendered acceptable and fit for human consumption.

Appendix 1: Typical carcase monitoring form

Establishment: _____

Date: _____

Shift: _____

Record all defects for each carcase/side sampled in a separate row.

The process is rated

- **Acceptable** if the calculated defect rating (total number of defects/ number of samples) is less than or equal to 0.25.
- **Unacceptable** if
    - One or more ZT defects are detected on any one carcase/side.
    - The calculated defect rating (total number of detects/ number of samples) is greater than 0.25.

Time	Species	Number of defects	Defect Description / Corrective Action

Total number of samples: _____

Defect Rating = Total number of defects ÷ Total number of samples =

QC Officer Name: _____

QC Officer Signature: _____

Appendix 2: How to use the CMA Form for High-risk products

Suppose you are producing lamb shanks as a High-risk product.
You monitor lamb shanks every 60 minutes of their production.
Below is an example of the inspection form completed for 4 & 5 February.
The first detection of a defect (at 12:21) does not result in corrective action as no defect had been detected in the previous cartons of lamb shanks checked during the shift. However, a second defect at 14:51 means corrective action is required as there are now two defects detected during the shift.
No defects are detected and recorded on 5 February.

Establishment: _____

Date: _____

Shift: _____

High-risk CMA product: _____

Record each separate carton sampled in a separate row.

The process is rated

- **Acceptable** if at most 1 non zero-tolerance defect is detected over all the sampled cartons during a shift.
- **Unacceptable** if
    - One or more ZT defects are detected in any one carton
    - More than one non-ZT defects are detected over all the sampled cartons during a shift
    - More than one non-ZT defects are detected in any single carton

Date	Time	Number of defects	Defect Description / Corrective Action
4 Feb	06:05	0	
	07:05	0	
	08:05	0	
	09:20	0	Includes 15-minute work break
	10:22	0	
	11:20	0	
	12:21	1	Hide fragment, 1.5cm GD
	13:47	0	Includes 30-minute work break
	14:51	1	16 wool strands – 2 defects during the shift **Corrective action required.**
	15:50	0	
5 Feb	06:10	0	
	07:08	0	
	08:13	0	
	09:09	0	Includes 15-minute work break
	10:24	0	
	11:18	0	
	12:22	0	
	13:51	0	Includes 30-minute work break
	14:48	0	
	15:45	0	

Appendix 3: Low risk CMA monitoring form

Establishment: _____

Date: _____

Shift: _____

Record each separate carton sampled in a separate row.

The process is rated

- **Acceptable** if at most 1 non zero-tolerance defect is detected in over all the sampled cartons during a shift.
- **Unacceptable** if
    - One or more ZT defects are detected in any one carton
    - More than one non-ZT defects are detected in any single carton
    - More than one non-ZT defects are detected over all the sampled cartons during a shift

Date	Time	Product Type	Number of defects	Defect Description / Corrective Action

QC Officer Name: _____

QC Officer Signature: _____

Appendix 4: High risk offal monitoring form

Establishment: _____

Date: _____

Shift: _____

High-risk offal product: _____

Record each piece of offal sampled in a separate row.

The process is rated

- **Acceptable** if the calculated defect rating (total number of defects / the number of samples) is less than or equal to 0.084.
- **Unacceptable** if
    - One or more ZT defects are detected in any one piece of offal
    - The calculated defect rating (total number of detects / the number of samples) is greater than 0.084.

Time	Number of defects	Defect Description / Corrective Action

Total number of samples: _____

Defect Rating = Total number of defects ÷ Total number of samples =

QC Officer Name: _____

QC Officer Signature: _____

Appendix 5: Low risk offal monitoring form

Establishment: _____

Date: _____

Shift: _____

Record each piece of offal sampled in a separate row.

The process is rated

- **Acceptable** if the calculated defect rating (total number of defects / the number of samples) is less than or equal to 0.084.
- **Unacceptable** if
    - One or more ZT defects are detected in any one piece of offal
    - The calculated defect rating (total number of detects / the number of samples) is greater than 0.084.

Time	Product Type	Number of defects	Defect Description / Corrective Action

Total number of samples: _____

Defect Rating = Total number of defects ÷ Total number of samples =

QC Officer Name: _____

QC Officer Signature: _____

8.4 Webinar Feedback Responses

Questionnaire responses Webinar 1

	Mean	Min	Max
The workshop met my expectations	4.2	3	5
The How-to guide was useful for the webinar	4.3	4	5
The webinar content covered what I need	4.0	2	5
There was plenty of opportunity for questions	4.5	4	5
The presenters were able to answer the questions	3.7	1	5
I'm more confident about amending my AA	3.3	1	5

*Score range of 1 for Disagree up to 5 for Agree

Your comments

What did you like most about the webinar?

Participant	Comment
1	It was simple and all aspects were explained in a practical sense.
2	Short and brief presentation.
3	I think it was useful having people in the webinar who have used/implemented MHA3.
4	I liked the interaction between some of the guests as they were able to share their experiences with the use of the pilot versions of the set-up. There was some informed discussion on how it actually works for a plant in real time. Personally, I feel more comfortable when a seminar is held and Team SARDI are part of the working team as I feel we get some real objective feedback and honest commentary around the topics discussed.
5	How-to guide provided focus for introduction. Useful introduction to our consideration of MHA 3.
6	Very informative and addressed the issues I was concerned about.

What did you like least about the webinar?

Participant	Comment
1	Got a bit hard to hear at times especially with echo.
2	Questions asked through audio. I prefer questions asked through chat box.
3	None
4	The background noise and some people's inability to mute their sound.
5	Lack of true clarity.
6	The echoing during the introduction.

Any other comment you would like to make?

Participant	Comment
1	Thanks for all your hard work.
2	None
3	None

4	It would be good to see how DAFF's updated WI's align with MHA V3, currently they don't but they need to be reflective of the changes so that there are clear alignments.
5	We would like incontrovertible definitions of these terms: (i) the last clear check (ii) contributing product.
6	Well done to all the people involved in putting on this group information session.

Response from SARDI

Thanks to the six participants who responded and especially for your comments.

We need to concentrate on the adverse responses:

Urine as a contaminant

It remained in MHA 2 and when we presented the table and excised the parts not in MHA 3, we missed that urine remained as a ZT. We have included the tables from the How-to document, which are correct, in the Powerpoint presentation (attached).

It is in MHA 3 as a contaminant, which it definitely is, particularly in smallstock and should be removed at point of spillage.

Last clear check

This will vary according to how you schedule your monitoring – Slides 27 and 38 indicate how high and low risk products might be scheduled and this will dictate your 'last clear check'.

Contributing product

These are products that have delivered the unacceptable product (2 defects or a ZT). It could be straightforward as with tongues (reinspect all tongues available) or more complicated as with head meats (you could be packing trimmings from skull, cheeks and jaws).

Align with DAFF document

DAFF inform us that a final draft has been sent to AMIC and non-AMIC establishments for review and comment (until mid-March 2023). You may want to contact AMIC for your opportunity to input and seek clarification.

Questionnaire responses Webinar 2

	Mean	Min	Max
The workshop met my expectations	4.5	4	5
The How-to guide was useful for the webinar	4	4	4
The webinar content covered what I need	3.5	3	4
There was plenty of opportunity for questions	5	5	5
The presenters were able to answer the questions	5	5	5
I'm more confident about amending my AA	4	4	4

*Score range of 1 for Disagree up to 5 for Agree

Your comments

What did you like most about the webinar?

Participant	Comment
1	Knowledgeable and articulate presenters willing to answer all questions.
2	There wasn't anything we didn't like it was presented well.

What did you like least about the webinar?

Participant	Comment
1	The time
2	None

Any other comment you would like to make?

Participant	Comment
1	The webinar and content were excellent. Answered 3 to "The webinar content covered what I need" as I believe when DAFF becomes involved in the development of our new AA they will muddy the waters considerably. Hopefully Jason Ollington can remain involved and provide some sensible direction to some on-plant DAFF staff.
2	None

Questionnaire responses Webinar 3

	Mean	Min	Max
The workshop met my expectations	4.7	4	5
The How-to guide was useful for the webinar	4.7	4	5
The webinar content covered what I need	4	4	5
There was plenty of opportunity for questions	4.7	4	5
The presenters were able to answer the questions	4	4	5
I'm more confident about amending my AA	4	3	5

*Score range of 1 for Disagree up to 5 for Agree

Your comments

What did you like most about the webinar?

Participant	Comment
1	The explanation of how the MHA3 system works was excellent, and I feel very confident in applying it to our AA. The material was well presented, and easy to follow and understand.
2	Generally informative interaction.
3	How to conduct the risk assessment for the low and high risks product was what I liked the most, because this was a task I was not sure about, and now I have a very good understanding of the approach to take to conduct the risk assessment. The whole presentation was really good, very comprehensive.

What did you like least about the webinar?

Participant	Comment
1	Nothing really. It was a consistent, high standard.
2	None
3	None

Any other comment you would like to make?

Participant	Comment
1	Thank you for organising and delivering the seminar. It was concise, informative, and to the point. Which is really appreciated by those of us that had been at work for many hours by that part of the day. The only comment that I would make is that it would have been good to have a Dept of Ag representative sitting in on the seminar to observe and take note of some of that were asked, particularly around the subject of our AAs. Especially if updating our AA to MHA3 constitutes a major change, requiring an EX26B to be lodged. The prospective 120-day timeframe for major AA approvals may put us in a bit of a scramble to get everything ready. This is the reason that I scored a couple of sections at 3 and is not a reflection of the knowledge of the people presenting the seminar.
2	Whether the change to MHA3 and also each risk assessment is a significant change to the AA needs to be defined quickly as there will be several drafts and amendments to it as it is written into the AA.

	Application and slow EX2B process may delay implementation and affect establishments' ability to achieve the deadline date.
3	No comment, as mentioned above, this was a very good presentation, very easy to follow and well explained.