final report

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Trim UV Light E. coli Intervention

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Executive Summary

The microbiological cleanliness of conveyor belt surfaces is paramount for food safety in the meat processing industry.

The aim of the project was to establish the microbiological decontamination capability of the Heraeus SteriBelt 2.0 Module UV lamp unit fitted to the lamb shoulder belt in the lamb boning. Production belts often operate for long periods without cleaning. During this time there is potential opportunity for a build-up of bacteria to occur which could be transferred to the product.

The production procedures and practices achieved non-detectable E.coli contamination on the Lamb shoulder belt during the full period of the production shift during the trial period

Furthermore, no bacteria were detected at the start of the production shift when the belt has been cleaned and sanitized. Australian Standard AS2997-1987 suggested that surface counts of up to 6 microorganisms/cm^2 (by the swab method) indicate satisfactory cleaning operations.

The Total Bacteria Counts of the Lamb Shoulder Belt surfaces during the two production shifts mentioned above were also relatively low (peaking below 30 microorganisms/cm^2). The use of the Heraeus SteriBelt 2.0 Module UV lamp fitted to the lamb shoulder line was very effective in further reducing the TBC by 0.7 logs on the belt surface as tested.

The installation of the SteriBelt modules is a simple and effective intervention for reducing bacteria build-up on product belts during the production shifts. It can be retrofit to almost any production belt with minimal modifications or expense, however the cost of the UV lamps and maintenance are costly and could potentially outweigh the benefits.

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1 Background

The microbiological cleanliness of conveyor belt surfaces is paramount for food safety in the meat processing industry.

This project was initiated by a lamb establishment and carried out by Levay & Co. Environmental Services.

The aim of the project was to establish the microbiological decontamination capability of the Heraeus SteriBelt 2.0 Module UV lamp unit fitted to the lamb shoulder belt in the lamb boning section. Production belts often operate for long periods without cleaning. During this time there is potential opportunity for a build-up of bacteria to occur which could be transferred to the product.

2 Projective Objectives

The objectives as they specifically relate to this project include:

- Design drawings and specifications for the UV application equipment which is to be modified for use within a red meat processing facility
- Methodologies for UV application
- Design drawings for the UV system to achieve the required contact and application
- Ideal product contact with the UV
- The appropriate application method of the UV
- The appropriate application flow rate of trim past the UV system
- Conveyor belt speed required to maximise efficiency and intervention efficacy

3 Methodology

3.1 Site Operating Conditions

The lamb shoulder belt at Murray Bridge was selected for the trial. The belt is 15 m long, 610 mm wide and operates at a speed of 12 m/min. The surface of the belt is made of Polypropylene.

Thorough cleaning of the conveyor belt is performed after the afternoon shift which operates from 3:30 pm to 2:00 am. A disinfectant sanitiser is used during cleaning (“Dual-Quat Sanitizer” supplied by Spurrier Chemical Companies Ltd). The active chemical ingredients of this sanitizer are Alkyl Dimethyl Benzyl and Ethyl Benzyl Ammonium Chlorides. The sanitizer is applied onto the surface of the conveyor belt in dilute solution (1:10 dilution with water).

The same sanitizer solution is sprayed onto the surface of the conveyor belt during the lunch breaks (11:00 to 11:30) of morning shifts. No mechanical cleaning of the belt is carried out either before or after sanitizer spraying.

3.2 Trial Installation Set-Up

The UV lamp unit fitted to the lamb shoulder belt was Heraeus SteriBelt SB650 with the following specifications

- Construction 316L Stainless Steel (IP67 rated)
- Overall length 880 mm
- Window dimensions 650mm L x 25mm W
- Distance to the belt 9mm
- Power consumption 80 Watt
- Irradiance at surface of belt (as tested) 25.5mW/cm2 @ 9mm.

Photos of the trail UV unit fitted to the conveyor belt are shown in Figures 1, 2 and 3 below.

WHS factors were also considered as part of the trial installation. Acute exposure to UVC (short wave length Ultraviolet 100 – 290nm) can result in 'sunburn' and the condition known as 'arc-eye', a sensation of sand in the eyes. The design and installation of the Heraeus UV products ensure that these factors are minimised. Exposure to UVC light is extremely minimal due to the proximity of the lamp tot the belt. This ensures there are no issues with UVC exposure to staff working within close proximity.

Figure 1: Steribelt Trial Installation

Figure 2: Steribelt 9mm set up

Figure 3: Steribelt operating on belt

3.3 Experimental Procedures

Calibration tests were conducted to establish the routine conveyor belt operating conditions and to optimise sampling procedures for microbiological testing.

The conveyor belt was operated with the UV lamp being turned off for the entire period of the morning shift (5:00 am to 2:30 pm). The objective of this was to establish the microbiological condition of the belt surface in the absence of UV disinfection.

The following day, the conveyor belt was operated with the UV lamp being turned on for the entire period of the morning shift. The purpose of this was to establish the microbiological condition on the belt surface in the presence of UV disinfection.

On each day, swab samples were collected from the belt surface according to Australian Standard AS 2997–1987 Appendix B. Two grid sizes were used for swabbing, 50 cm^2 and 25 cm^2. Duplicate swab samples were taken before operation began (freshly cleaned belt surfaces = time 0 hours), approximately 1.5, 3, 6, and 7.5 hours during the morning shift and at the end of the shift (about 8.75 hours). Microbiological testing of swab samples included E.coli counts and Total Bacterial Counts (TBC). The “Direct Plate-Out Method” and “Pour Plate Method” were used.

The “Direct Plate-Out Method” for TBC was carried out according to Australian Standard AS 4709–2001. The “Direct Plate-Out Method” for E coli counts was carried out according to IMVS Method FH32.6.

The “Pour Plate Method” for TBC was carried out according to IMVS Method FH30.2. The “Pour Plate Method” for E. coli counts was carried out according to Method AOAC 991.14.

The “Direct Plate-Out Method” can provide accurate TBC and E. coli counts to a maximum of 300 cfu (colony forming units) per swab. Results reported above this limit are only estimates.

Consequently, the maximum number of TBC and E. coli that can be accurately quantified per cm^2 of belt surface area for the 25 cm^2 swab grid was two time higher than for the 50 cm^2 swab grid (12 cfu/cm^2 and 6 cfu/cm^2 respectively).

The “Pour Plate Method” was used to increase the upper limit of TBC and E. coli counts of swab samples. This method consisted in extraction of swab samples in a nutrient solution and plating out of this extract after dilution.

Elevated levels of TBC and E. coli were expected to be more likely in the later part of the morning shift. Consequently, swab samples were collected for the “Pour Plate Method” at 3, 6, 7.5 and 8.75 hours.

Swab samples for the “Direct Plate-Out Method” were collected at each sampling time (0, 1.5, 3, 6, 7.5 and 8.75 hours).

On both trial days, the belt was cleaned and sanitised prior to sampling at the start of the shift (0.00 hours operating time). The belt was then sanitised but not cleaned following sampling at 6.00 hour operating time.

4 Results & Discussion

TBC were non-detectable at the start of the morning shift when the belt had been cleaned and sanitized. E. coli were not detected in any of the swab samples collected.

A summary of TBC results obtained with the “Direct Plate-Out Method” is given Table 1 and Figure 4. The test results clearly indicate a significant reduction in TBC as a result of UV disinfection, with the exception of the swab sample collected at 7.5 hours.

Table 1: 'Direct Plate-Out Method' TBC Results, with & without UV Disinfection

	No UV Disinfection		With UV Disinfection	
Operation Time (h)	Average TBC (organisms/cm^2)	Standard Error TBC (organisms/cm^2)	Average TBC (organisms/cm^2)	Standard Error TBC (organisms/cm^2)
0.00	0	0	0	0
1.50	22	9.1	0.97	0.07
3.00	1.7	0.37	0.71	0.95
6.00	8.4	2.8	0.23	0.014
7.50	2.5	0.69	6.6	8.8
8.75	1.5	0.38	0.36	0.3

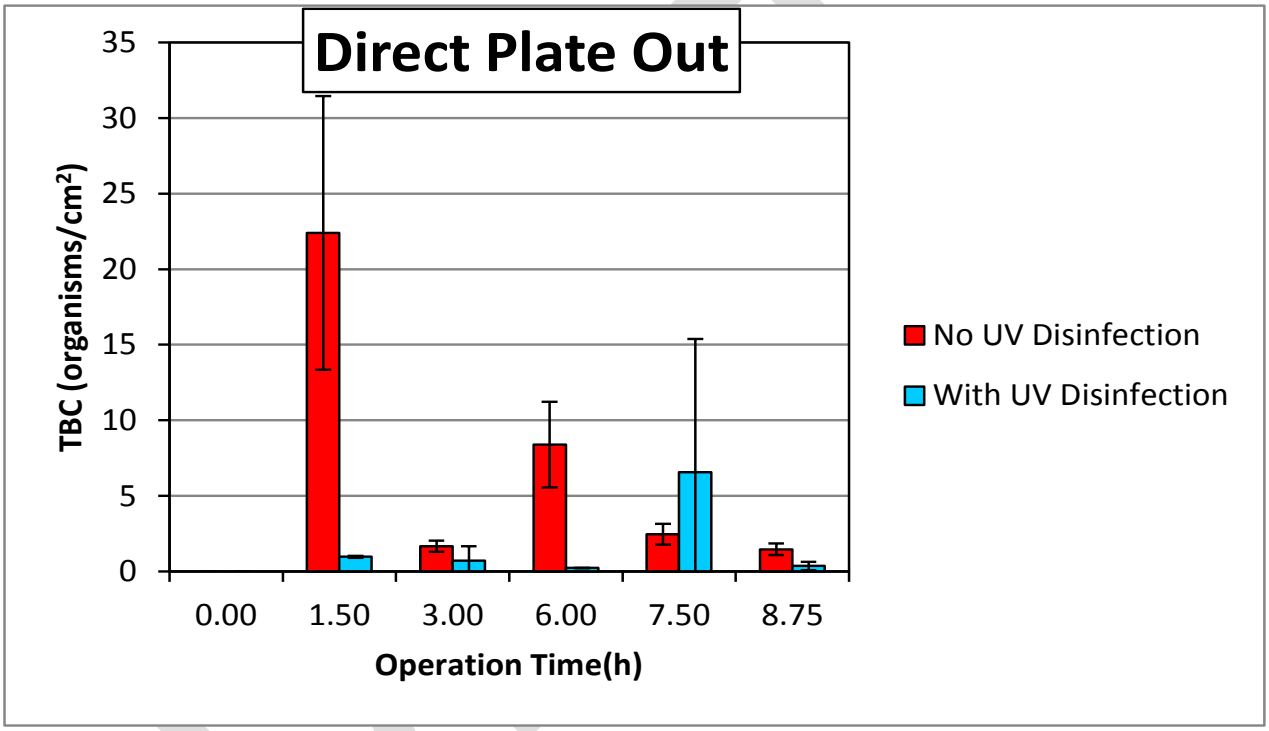

Figure 4: TBC results obtained with the 'Direct Plate-Out Method', with & without UV Disinfection

A summary of TBC results obtained with the “Pour Plate Method” is given in Table 2 and Figure 5. The test results again indicate a significant reduction in TBC as a result of UV disinfection, with the exception of the swab sample collected at 3 hours.

Table 2: 'Pour Plate Method' TBC results with & without UV disinfection

	No UV Disinfection		With UV Disinfection	
Operation Time (h)	Average TBC (organisms/cm^2)	Standard Error TBC (organisms/cm^2)	Average TBC (organisms/cm^2)	Standard Error TBC (organisms/cm^2)
0.00				
1.50				
3.00	13	14	14	15
6.00	9.3	1.3	2.9	1.6
7.50	22	11	2.5	0.14
8.75	16	1.0	3.7	3.5

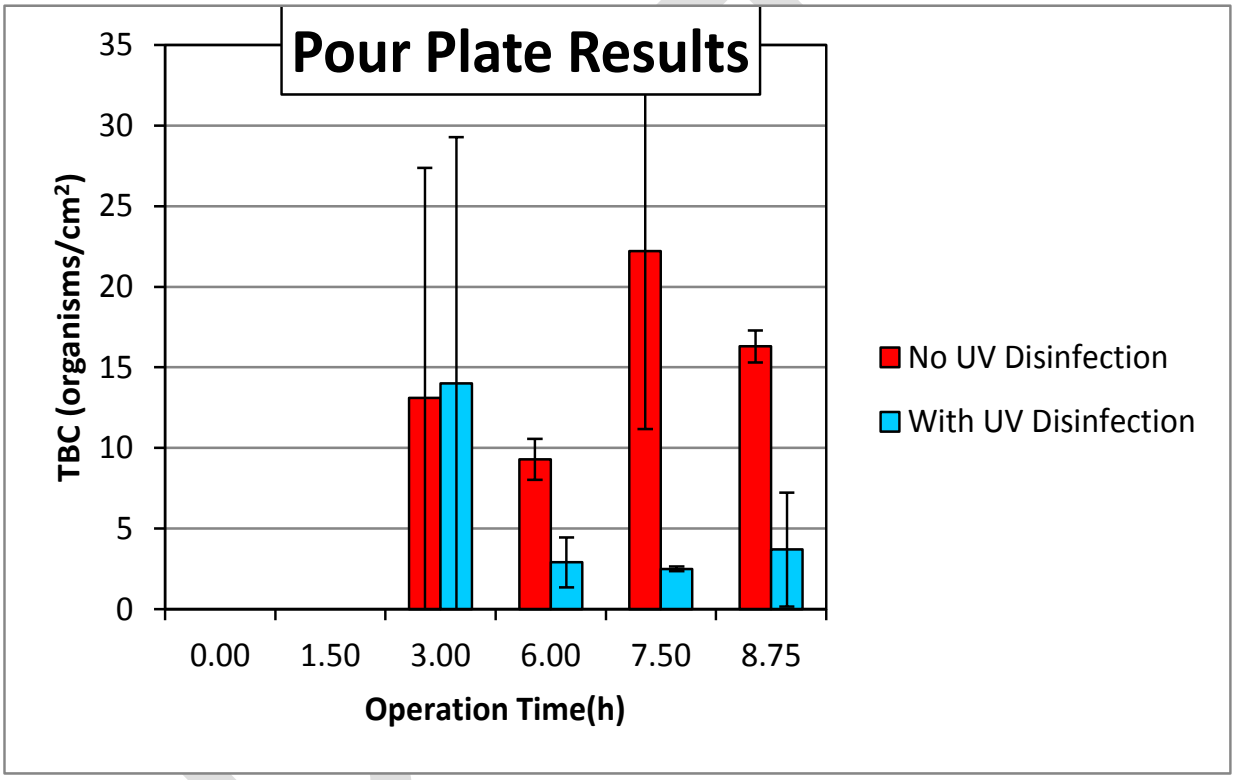

Figure 5: TBC results obtained with 'Pour Plate Method' with & without UV disinfection

Generally, TBC were higher for the “Pour Plate Method” than the “Direct Plate-Out Method”. This is likely due to better transfer of bacteria from the swab to the nutrient solution than from the swab directly onto the agar plate.

For the two samples in which the TBC were not lower when the UV lamp was operating, *i.e.* 3 h sample (pour plate method) and 7.5 h sample (direct plate out method); in both cases the results of the duplicate samples taken at each sampling time were very different. For the 3 h sample, the duplicate samples gave results of 3.2 organisms/cm^2 and 25 organisms/cm^2. The first result is in line with the other results for the pour plate method with the UV lamp operating, but the second much higher result means that on average, the TBC is substantially higher for this sample than

for the others. Similarly, for the 7.5 h sample, the duplicate TBC results from the direct plate out method were 13 and 0.32 organisms/cm^2. Again, the lower result was in line with other results for the direct plate out method with the UV lamp operating, so it is the higher duplicate result which provides a higher than expected average TBC. It should be noted in this instance, the high result *i.e.* 13 organisms/cm^2 is an estimate only, as the original result was 640 organisms per swab (before calculation on a per area basis), which is well above the quantifiable limit of 300 organisms per swab. This puts further qualification on this particular result.

Whether the disparity between the duplicate samples in these cases was due to genuine contamination of the particular area of the belt being swabbed, or the samples were contaminated subsequent to swabbing, it is not possible to say based on the data available. However, this does not take away from the overall results, which clearly indicate that for the majority of samples, TBC were significantly lower when the UV lamp was operating, than when it was not in operation.

5 Conclusions/Recommendations

The production procedures and practices achieved non-detectable E.coli contamination (<0.20 organisms/cm^2) on the Lamb shoulder belt during the full period of the production shift during the trial period

Furthermore, no bacteria were detected at the start of the production shift when the belt has been cleaned and sanitized. Australian Standard AS2997-1987 suggested that surface counts of up to 6 microorganisms/cm^2 (by the swab method) indicate a satisfactory cleaning operations.

The Total Bacteria Counts of the Lamb Shoulder Belt surfaces during the two production shifts mentioned above were also relatively low (peaking below 30 microorganisms/cm^2). The use of the Heraeus SteriBelt 2.0 Module UV lamp fitted to the lamb shoulder line was very effective in further reducing the TBC of the belt surface as tested.

WHS factors should be considered as part of any UV installation. Acute exposure to UVC can result in ‘sunburn’ and the condition known as ‘arc-eye’, a sensation of sand in the eyes. The design and installation of the Heraeus UV products ensure that these factors are minimised. Exposure to UVC light is extremely minimal due to the proximity of the lamp to the belt. This ensures there are no issues with UVC exposure to staff working within close proximity. A ‘shield’ or cover can be fitted above the unit if required, although this is not necessary.

The installation of the SteriBelt modules is a simple and effective intervention for reducing bacteria build-up on product belts during the production shifts. It can be retrofit to almost any production belt with minimal modifications or expense. The results of the trial show a 0.7 log reduction with the use of UV. This is considered a ‘practical’ solution; however a larger data set across multiple days and varying stock would be required to further confirm the result.

6 Bibliography

6.1 Heading

6.1.1 Sub heading

Normal text

Guidelines: The Bibliography should be in the same style as the CSIRO's Animal Production Science Journal (http:/www.publish.csiro.au/nid/72.htm)

7 Appendix

7.1 Lamb Shoulder Belt

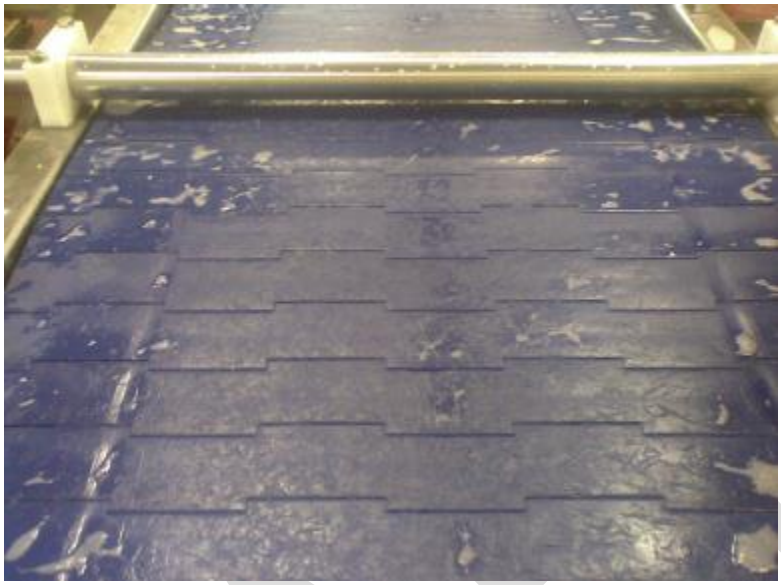

Figure 6: Day 1 Lamb Shoulder Belt 05:00 (prior to commencement of production shift). No UV Disinfection

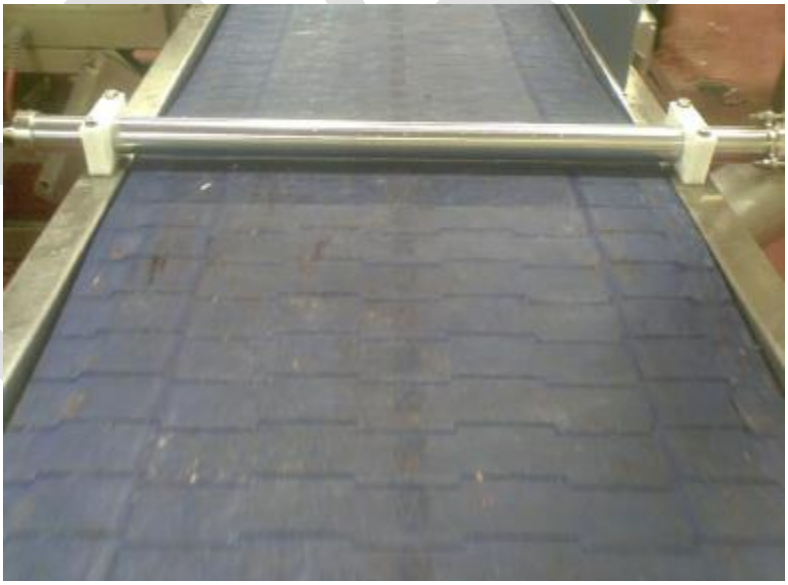

Figure 7: Day 1 Lamb Shoulder Belt 07:00 - No UV Disinfection

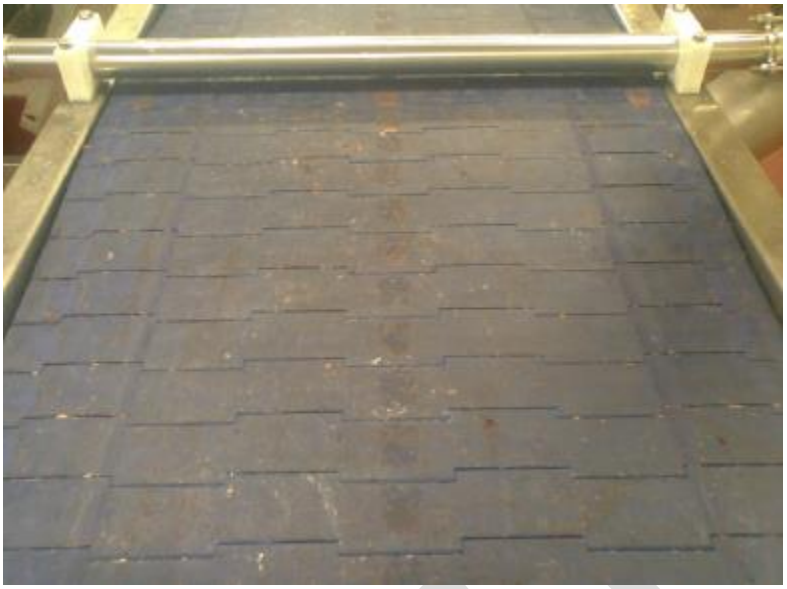

Figure 8: Day 1 Lamb Shoulder Belt 08:30 - No UV Disinfection

Figure 9: Day 1 Lamb Shoulder Belt 11:15 - No UV Disinfection

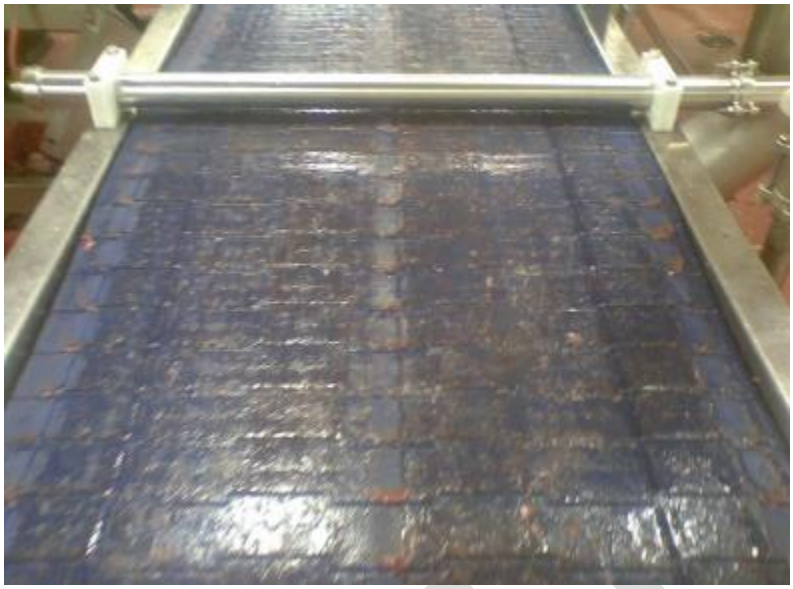

Figure 10: Day 1 Lamb Shoulder Belt 11:15 after application of sanitiser - No UV Disinfection

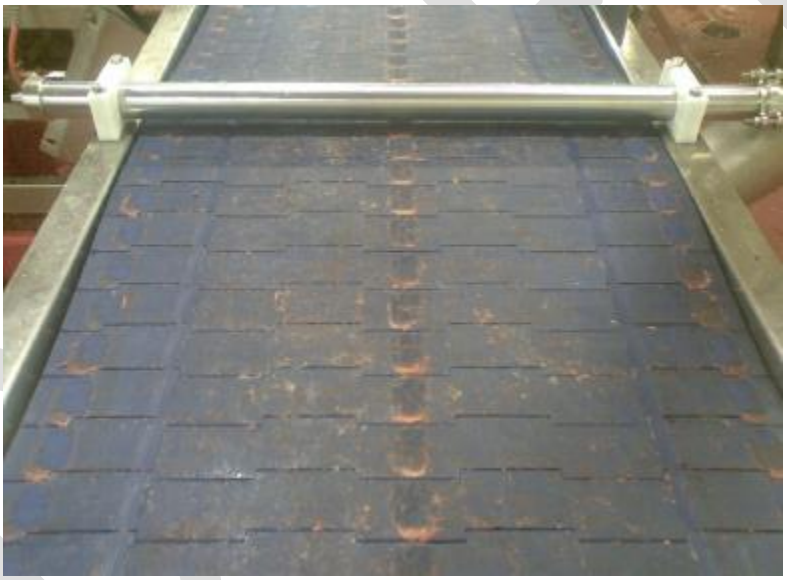

Figure 11: Day 1 Lamb Shoulder Belt 13:20 - No UV Disinfection

Figure 12: Day 1 Lamb Shoulder Belt 14:45 - No UV Disinfection

Figure 13: Day 1 Swabbing Lamb Shoulder Belt 14:45 - No UV Disinfection

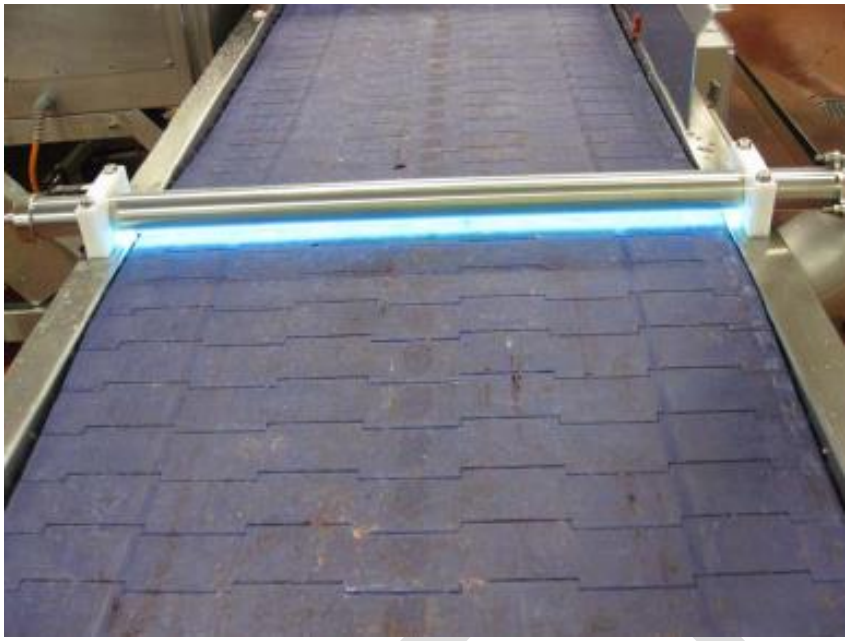

Figure 14: Day 2 Lamb Shoulder Belt 05:46 with UV disinfection

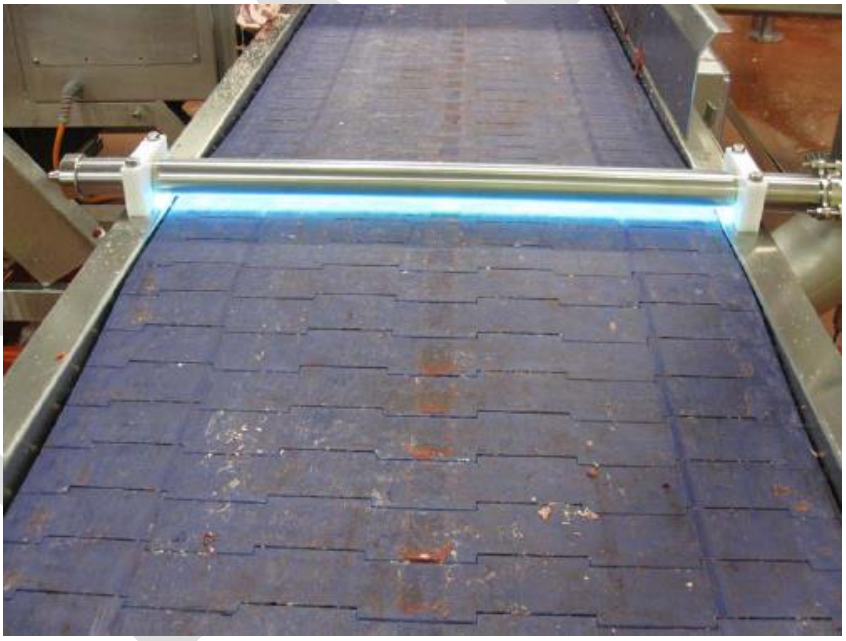

Figure 15: Day 2 Lamb Shoulder Belt 07:24 with UV Disinfection

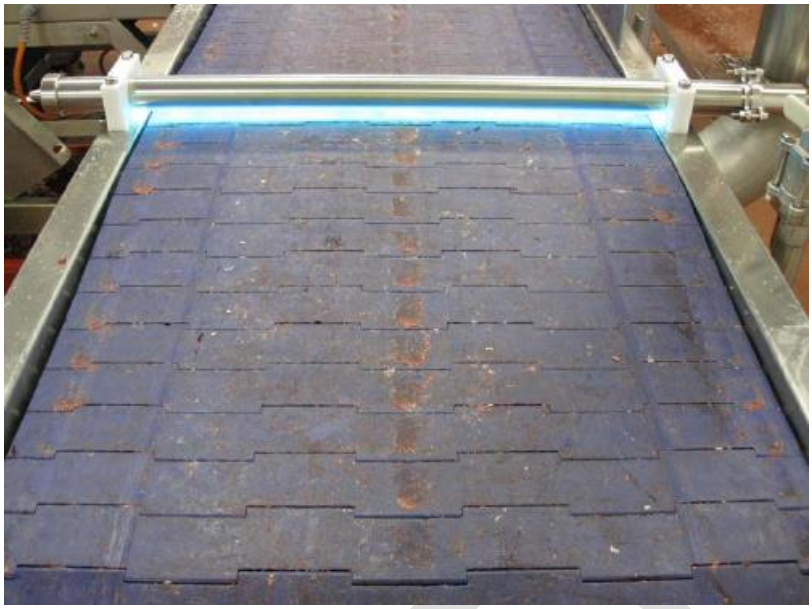

Figure 16: Day 2 Lamb Shoulder Belt 10:15 with UV Disinfection

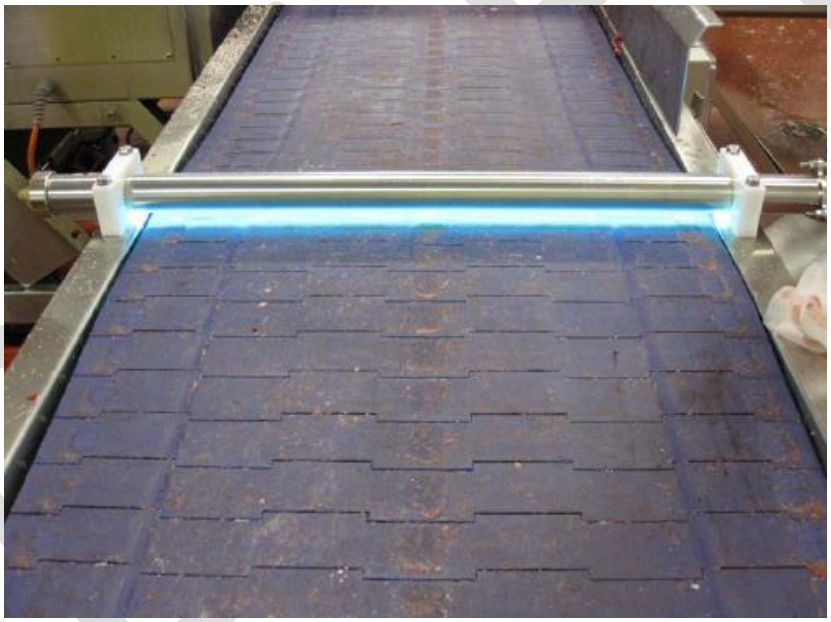

Figure 17: Day 2 Lamb Shoulder Belt 12:24 with UV Disinfection

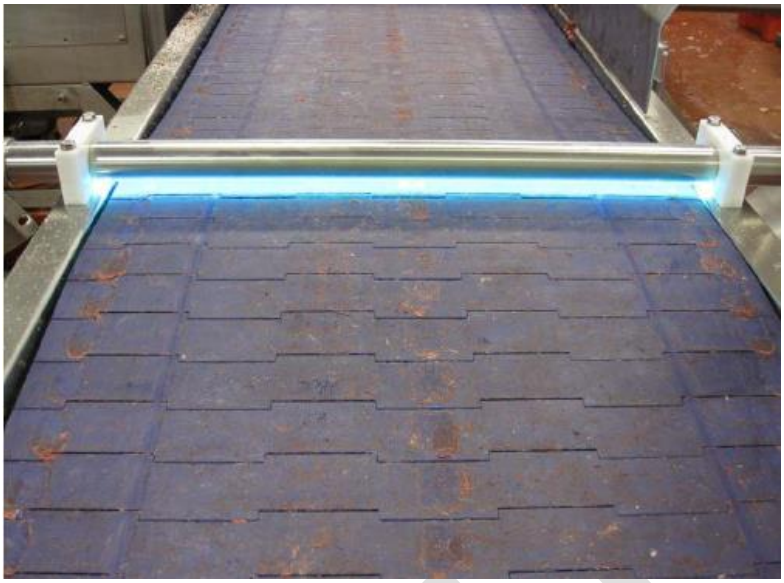

Figure 18: Day 2 Lamb Shoulder Belt 13:31 with UV Disinfection