



# **Final report**

# Evaluation of an innovative processing technology for production efficiencies and cost savings in food processing including red meat

Project code:	P.PSH.1273
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Date published:	30 April 2023

PUBLISHED BY Meat & Livestock Australia Limited PO Box 1961 NORTH SYDNEY NSW 2059

This is an MLA Donor Company funded project.

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

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#### Abstract

The proposed project will bring commercially proven air and surface purification technology in global applications to Australia for validation in a specific Stage 1 application in red meat processing. The current project proposes to evaluate the application of an innovative processing technology for production efficiencies and cost savings in red meat processing, specifically in ready retail meat products. Specifically, the project will evaluate air and surface purification technology to deliver more efficient and cost effective hygienic processes than the current manual wet cleaning methods required prior and periodically throughout red meat production.

The project aims to evaluate *Active Photocatalytic Oxidation (PCO)* technology to reduce &/or *eliminate airborne and surface pathogens*, including SARS-CoV-2 (novel coronavirus) and its variants, for its potential to *extend shelf life of food products* with inclusion of red meat. In addition to reviewing the potential effectiveness of reducing the health risks in the workplace and improved food safety, this project will also evaluate specific applications for red meat processing and the process steps for successful implementation. The expected profitability gains through widespread introduction are likely to be shared up and down the value chain with producers, suppliers and customers.

# **Executive summary**

#### Background

Australian red meat processing has exemplar food hygiene standards, which comes at significant cost to the business. It is generally considered that the cost of maintaining the required high hygienic standards is in the top 10 highest costs of meat production. Specifically, retail ready operations estimate the overall cost of maintaining a high hygienic standard could be 10-15% of the cost of production. There are significant production efficiencies and opportunity cost savings that could be delivered by *more efficient and cost effective hygiene maintaining procedures*. Coles, RROA and MLA are partnering on an innovative processing technology that is new to Australia and food processing including red meat.

The current project proposes to evaluate the application of an innovative processing technology for production efficiencies and cost savings in red meat processing, specifically in retail ready meat products. While used in various proven applications in medical and food production applications globally, this will be the first application of this technology in Australia and for red meat processing. There are expected to be significant benefits and impacts to the red meat industry with the application of this new technology in production efficiencies and cost savings to maintain and likely exceed the current high food hygienic standards.

To mitigate the very real and present risks of harm caused by exposure to **SARS-CoV-2** (novel coronavirus) and the resulting disease, **COVID-19**, and other pathogens, this project seeks to evaluate new technology, specifically Active Photocatalytic Oxidation (PCO), that aims to reduce &/or eliminate airborne and surface pathogens, including SARS-CoV-2 (novel coronavirus), with the additional benefit of potential to extend shelf life of food products including red meat, reduce packaging material contaminants and reductions in HVAC pathogens such as mould.

The PCO phenomena was originally discovered by *Akira Fujishima*<sup>1</sup> in 1967, the so-called Honda Fujishima effect. This phenomenon was developed into an air purification system by NASA scientists in the 1990s for use on the Space Shuttle and International Space Station. Some of the key patents for this NASA technology were later acquired by *Puradigm*<sup>2</sup>, who in 2011, made a breakthrough that took this passive technology and developed it into an active, safe and scalable technology capable of reaching every corner of an enclosed space, *inactivating pathogens and volatile organic compounds in both the air and on surfaces.* 

**Real-world evidence as reported by certified labs** from several years of use at various hospitals, indoor grow facilities, food processing plants, university, school, office and retail spaces around the world, show high levels of reduction in both airborne and surface microbial loads, are achievable at scale.

The technology has been successfully tested at the *CSIRO's*<sup>3</sup> *Australian Centre for Disease Preparedness against SARS-CoV-2, Delta variant* which showed that the device has an active agent which was able to inactivate the virus on surfaces remote from the device, without elevating ozone above safe or pathogenic levels. The study did not investigate what the active agent is, as this has been investigated through many previous studies which showed it is comprised of water vapour surrounded by a non-thermal plasma (NTP) ie H+ and -O2 ions, basically a *charged water aerosol*. The ions are naturally produced outdoors and our bodies are adapted to live with them, so it is *totally safe, yet very effective* at destroying both bacteria and volatile organic compounds and inactivating

viruses of all types. When used continuously, this NTP, doesn't allow pathogens to build up and so doesn't need to be as harsh as general sanitation chemicals such as alcohol or other disinfectants. The most effective implementations are preventative rather than as a remediation method ie *prevention is better than cure*. However remediation is certainly possible, but just requires longer exposure times, as was shown in the results within this project for heavily contaminated surfaces.

The proposed project will bring this air and surface purification technology to Australia for validation in a specific Stage 1 applications within red meat processing. The project will provide insights and practical knowledge on how this publicly **available technology can be applied to benefit red meat production operations across the whole value chain**. It is envisaged that this may lead into further research aimed at incorporating the technology into MAP, Utilities, odour control in waste management and increased sanitation in equipment cleaning applications to provide additional microbial reduction with associated cost savings and efficiency gains.

This Stage 1 project will bring the air and surface purification technology to Australia for validation on specific applications in red meat processing in multiple phases. It will initially evaluate the air and surface purification technology in the Chef Fresh facility's packaging material decontamination rooms (previously ozone rooms). Subsequent phases will cover trials in real-world settings in RROA focusing on pathogen reduction in the HVAC system, implementation challenges for production environments, shelf life extension of food products and enhancing food safety trust.

The outcomes of this stage 1 validation in red meat processing will be applied to develop recommendations for adoption in red meat processing. The outcome will also be used to identify and inform any potential future R&D.

- 1. Akira Fujishima Akira Fujishima Wikipedia
- 2. Puradigm is a US-based company (<u>www.puradigm.com</u>) with local Australian distributor Pandara (<u>https://pandara.life</u>)
- 3. "Performance testing of Active PCO technology for SARS-CoV-2 inactivation on surfaces", CSIRO. Only available in full with permission by Coles Group Limited. The study aimed to confirm the existing study reports and enable internal Coles evaluation of the technology, and should not be deemed as an endorsement of the technology by the CSIRO.

#### **Objectives**

The overall objective is to evaluate air and surface purification technology for packaging material surface pathogen reduction, extended shelf-life and HVAC pathogen reduction in food processing, including in red meat. The project aims to evaluate new pathogen reduction technology that aims to reduce &/or eliminate airborne and surface pathogens, including SARS-CoV-2 (novel coronavirus), for its potential to extend shelf life of food products and reduce pathogen bioloads in various settings in Coles' manufacturing facilities with inclusion of red meat.

Specifically, the project aims are to:

- Gain an understanding of the efficacy of Active PCO technology in real-world environments against various microbial loads that are possible in red meat processing facilities with the view of continuing to provide leading edge hygiene standards with reduced need for interventionist cleaning regimes which interrupt production.
- Gain an insight into the efficacy of Active PCO technology in reducing intra-day and intra-species cleaning while maintaining shelf-life of food products, including red meat.
- Develop implementation designs for the various real-world environments to manage challenges such as air movements, large scale spaces, fast moving product, wash down procedures, etc.
- Identify use cases for the technology across the facility at RROA and Chef Fresh.

#### Methodology

*Milestone 1* will develop the detailed test schedules for the overall project, including Chef Fresh packaging decontamination, RROA HVAC pathogen reductions and RROA shelf-life extension trials.

*Milestone* **2** will focus on evaluating the technology in real-world settings against standard microbiological pathogens expected in the Chef Fresh packaging material decontamination rooms (old ozone rooms).

*Milestone 3* will focus on evaluating the technology in real-world settings within the RROA facility, testing against standard microbiological pathogens found in the air and on surfaces of the HVAC environments.

*Milestone 4* will evaluate the technology to investigate shelf life extension of food products and enhancing food safety trust.

*Milestone 5* is the final report detailing the outcomes of the packaging decontamination, shelf life extension, HVAC microbiological reduction and shelf life extension in combination with Denba.

#### **Results/key findings**

Microbiological Reductions on Primal Surfaces for various exposure times

24hr Exposures – 99% / 2 Log Reductions (35 day aged primals / Extremely high count)





>24hr Exposures – 99.99% / 4 Log Reductions (35 day aged primals / Extremely high count)

5 min Exposures – 90% / 1 Log Reductions (Fresh primals 10 day aged / Low count) 10 min Exposures – 100% / >8 Log Reductions (Fresh primals 10 day aged / Low count)



#### Microbiological Reductions on HVAC Air Handling Unit (AHU) Surfaces

Black mould is one of the most difficult microbiological pathogens to remove from air and surfaces. *Puradigm was able to keep the HVAC's AHU surfaces clean well beyond the usual 2 month cleaning period*. It should be noted these surfaces experience high humidity every night but this posed no issue for the Puradigm charged water aerosols. The air is being circulated during the day at very *high flow rates of 20 m<sup>3</sup>/s* per AHU. Every evening the plant is cleaned which produces large quantities of steam (*100% humidity*) and the AHU air flow rates are lowered to around 5 m<sup>3</sup>/s and ventilated to atmosphere. In this way the AHUs are subjected to some extreme conditions which are *more severe than seasonal humidity changes*.



#### Microbiological Reductions on Packaging Surfaces covered in Water

#### High concentration of staphylococcus submerged in water - no reductions

Large quantities of water will block the effect of Puradigm's charged water aerosols. However, as can be seen in the HVAC AHU trial, damp or dry surfaces experience significant and rapid reductions.

The Chef Fresh facility's packaging decontamination has two rooms, one with raw product packaging which is very wet and the other with dry packaging material. Puradigm is only suitable for the dry packaging material room, while alternate decontamination technology, is required for the heavily wet packaging material surfaces.



#### **Benefits to industry**

These trials confirm the effectiveness of Puradigm's air and surface purification technology within various red meat industry environments and detail the implementation considerations which are specific to this industry. *The following benefits are based on global research findings as well as those carried out in this project.* 

#### The benefits for the red meat industry are:

 Primary processors - Carcase surface purification over short or long exposure times – reduced reliance on chemical washes or DNA damaging interventions such as UV. Enhanced shelf-life of products.

- Primary & Secondary processors *Primal surface purification* over short exposures prior and during portioning. *Enhanced shelf-life of products*.
- Primary & Secondary processors *Cleaning of Air Handling Units, refrigeration coils* and surfaces, 24/7 cleaning, *reducing chemical clean frequency, usage and cost*
- Primary, Secondary and Supermarkets reducing air borne & surface pathogens including SARS-CoV-2, cold, influenza, norovirus and other bacteria and viruses and thereby keeping staff & customers safe, reducing absenteeism and enhancing the well-being of people, plants and animals.
- Primary & Secondary processors *Purification of external packaging surfaces* prior to opening within high risk production areas.
- Primary & Secondary processors Purification of production surfaces between chemical cleaning periods, *to minimise the risk of outbreaks such as listeria*, and *enhance shelf-life* of products.
- Supermarket *Reduce surface pathogens in deli and fresh produce aisles* to *enhance shelf-life* of products
- Puradigm is over **2400x** *faster than HEPA alone purification*, as the air is not required to pass through the Puradigm device, but instead every part of the volume of an indoor space is filled with the *natural charged water aerosols*, deactivating pathogens in seconds rather than 40 mins or more.
- **Safer and more effective than UV** which requires slow air flow and close proximity, and requires the air to be brought to the device. UV can also be blocked by shadowing and damages the DNA of products thereby changing its taste and texture.
- **Puradigm is safe for continuous operation in occupied spaces** keeping people and products protected at all times, never allowing pathogens to build up to unsafe levels which would then require harsh chemical interventions.

#### Future research and recommendations

Further research aimed at incorporating the technology into *MAP packaging, odour control* in waste management, *minimise offensive odours such as those from fish, equipment cleaning*, transportation of *fresh produce, transportation sanitation* for *mould control*, and *combined applications with Denba* to provide additional microbial reductions/control *for enhanced shelf-life of products*, reduced energy consumption for frozen products and enhance frozen products to fresh or sashimi-grade on defrosting.

*Trials in supermarkets* and *primary processing* to investigate optimal implementation strategies for the benefits listed above should be conducted.

Export market research analysis aimed at the benefits of certifying processing plants as COVID-19 safe production environments.

This project has confirmed that Puradigm represents a paradigm shift in purification, promising a wide range of benefits to all industries, including the red meat industry.

# Table of contents

Exec	utive	summary	3
1	Mile	stone Description	13
	1.1	Milestone 1	13
	1.2	Milestone 2	13
	1.3	Milestone 3	13
	1.4	Milestone 4	14
	1.5	Milestone 5	14
2	Back	ground	14
	2.1	Project purpose & scope	14
	2.2	Project Target Outcomes	
3	Mile	stone Outcomes	
	3.1	Milestone 1	18
	3.2	Test Schedule – Packaging Decontamination Room	.19
	3.2.1		
	3.2.2	Test Schedule – Packaging Decontamination Room – Test Method	20
	3.2.3	Test Schedule – Packaging Decontamination Room – Test Schedule	24
	3.3	Test Schedule – HVAC	.25
	3.3.1	Test Schedule – HVAC – Safety	. 25
	3.3.2	Test Schedule – HVAC – Test Method	25
	3.3.3	Test Schedule – HVAC – Test Schedule	27
	3.4	Test Schedule – Shelf-Life	.28
	3.4.1	Test Schedule – Shelf-Life – Safety	28
	3.4.2	Test Schedule – Shelf-Life – Test Method	29
	3.4.3	Test Schedule – Shelf-Life – Test Schedule	30
	4	Milestone 2	31
	4.1	Packaging Decontamination Room – Analysis of Environmental Conditions	.32
	4.2	Packaging Decontamination Room – Microbiological Reductions	.33

4.2.2	Packaging Decontamination Test Protocol	33
4.2.2	2 Packaging Decontamination Test Results	
4.3	HVAC Installation	37
4.4	Shelf-Life Room – Trial Preparation	39
4.5	Shelf-Life Room – Analysis of Environmental Conditions and 24hr Microbiological Reduction Trial	39
4.5.3	1 Shelf-Life 24hr Microbiological Reduction Test Protocol	
4.5.2	2 Shelf-Life 24hr Microbiological Reduction Test Results – Test 1	40
5	Milestone 3	45
5.1	Shelf-Life Room – Analysis of Environmental Conditions and 24hr Microbiological Reduction Trial	45
5.1.3	1 Shelf-Life 24-96hr Microbiological Reductions Test Results – Test 2 & 3	47
5.1.2	2 Shelf-Life 24-144hr 2hourly Microbiological Reductions Test Results – Test 4	58
6	Milestone 4	70
6.1	HVAC AHU – Analysis of Environmental Conditions and Microbiological Reduction Trials	70
6.2	Shelf-Life Room – Microbiological Reduction for Short Exposure Times	76
6.3	Shelf-Life Room – Microbiological Reduction for combined Denba and Puradigm exposures	77
7	Milestone 5	79
7.1	HVAC AHU –Microbiological Reduction Trials in real-world environmenta conditions	
7.2	Fresh primals – Microbiological Reduction Trials over short time frames	
Prim	als –Microbiological Reduction Trial Summary	93
7.3	Packaging Decontamination – Final report on effectiveness	93
7.4	Puradigm and Denba – Next Steps	94
7.5	Next Steps	94
Suco	cess in meeting the Milestone	95
8.1	Milestone 1	95
8.2	Milestone 2	95
8.3	Milestone 3	95
8.4	Milestone 4	96

8

	8.5 Milestone 5	96
9	Conclusions & Recommendations	96
	9.1 Conclusions	96
	9.2 Recommendations	96
10	APPENDIX - Supporting Documents	97
	10.1 Appendix 1 Coles Group - Vision, Purpose & Strategy	97
	10.2 Appendix 2 – Certifications	98

# **1** Milestone Description

### 1.1 Milestone 1

#### Design and detailed work testing schedule.

Design trials & testing methodologies, evaluate safety aspects and develop operating protocols for the purification technology. Procure test units. Develop a detailed project testing schedule. Identify key value propositions/ potential areas of application in red meat. Project steering group formed.

**Milestone 1 Report:** Progress report on design and detailed project schedule submitted to the project steering group & approved by MLA.

# 1.2 Milestone 2

Practical trials and initial testing in production environment, including:

- Microbiological reductions on packaging material within old ozone rooms
- Analysis of environmental conditions and design to maximise Ion efficiencies in new and old ozone rooms

**Milestone 2:** Progress report on practical trials and testing to be submitted to the project steering group and approved by MLA.

# 1.3 Milestone 3

#### Commission and production testing at Coles RROA.

Install trial units in RROA production HVAC locations. Design production trial methodologies. Collect and analyse test samples, including:

- Microbiological reductions in air and on surfaces within the HVAC environment
- Microbiological reductions on conveyor or machine surface

#### Shelf life trials

• Microbiological reduction trials over 24, 96 and 144hrs

**Milestone 3:** Progress report on commission of production trials and testing to be submitted to the project steering group and approved by MLA.

# 1.4 Milestone 4

#### Commission and production testing at Coles RROA.

Start testing RROA production HVAC locations. Collect and analyse test samples, including:

• Microbiological reductions in air and on surfaces within the HVAC environment

#### Shelf life trials

- Microbiological trials on fresh primals to determine speed of reduction for short duration exposure
- Design for combination of Denba and Puradigm for maximum reductions

**Milestone 4:** Progress report on commission of production trials and testing to be submitted to the project steering group and approved by MLA.

### 1.5 Milestone 5

Deliver key functions such as:

Practical trials in production environment, including:

- Microbiological reduction final report on effectiveness in various conditions and timeframes.
- Results for HVAC trials in Air Handling Units, for extremely high speed air currents
- Puradigm and Denba combined shelf life extension trials
- Packaging decontamination final report on effectiveness

**Milestone 5:** Final report on practical trials and testing to be submitted to the project steering group and approved by MLA.

# 2 Background

#### 2.1 Project purpose & scope

The overall objective is to evaluate air and surface purification technology for packaging material surface pathogen reduction, extended shelf-life and HVAC pathogen reduction in food processing, including in red meat. The project aims to evaluate new pathogen reduction technology that aims to reduce &/or eliminate airborne and surface pathogens, including SARS-CoV-2 (novel coronavirus), for its potential to extend shelf life of food products and reduce pathogen bioloads in various settings in Coles' manufacturing facilities with inclusion of red meat.

Specifically, the project aims are to:

- Gain an understanding of the efficacy of Active PCO technology in real-world environments against various microbial loads that are possible in red meat processing facilities with the view of continuing to provide leading edge hygiene standards with reduced need for interventionist cleaning regimes which interrupt production.
- Gain an insight into the efficacy of Active PCO technology in reducing intra-day and intra-species cleaning while maintaining shelf-life of food products, including red meat.
- Develop implementation designs for the various real-world environments to manage challenges such as air movements, large scale spaces, fast moving product, wash down procedures, etc.

Identify use cases for the technology across the facility at RROA and Chef Fresh

# 2.2 Project Target Outcomes

#### Value proposition and benefits to the Australian red meat industry

The primary proposition of the project is to deliver significantly more efficient and cost effective hygienic processes than the current manual wet cleaning methods required prior, and periodically throughout, red meat production or the dangerous use of ozone or UV. It is proposed that continuous sanitation throughout production will deliver benefits to labour and utilities (energy and water savings), and asset utilisation improvement with minimal manual washdowns between change of production runs and within the HVAC system. Additionally, the technology aims to reduce and/or eliminate airborne and surface pathogens (including viruses such as SARS-CoV-2), and thereby potentially extending shelf life of retail ready red meat products. Reduction and/or elimination of pathogen and viruses, could provide safer workplace environments in meat processing and minimal disruption to production at times of operator illness or outbreaks.

The value proposition for the Australian Red Meat Industry of utilising Active Photocatalytic Oxidation technology may be:

- i.Log Reduction (for example, in applications the production surfaces are continuously sanitised throughout production achieving results of up to 95% reduction in microbial loads)
- ii.Water Saving The sanitisation process achieved within the air handling systems and production rooms may reduce the need to perform the same frequency of intra-day or intra-species cleaning which requires sanitisation of components with traditional hot water methods, thus resulting in significant water saving benefits.
- iii.Labour Saving significant labour resources are spent in maintaining GMP standards. These resources would be significantly reduced with the application of this continuous sanitisation technology.
- iv.Power Saving significant power is consumed in generating the required air movements through HEPA filtration systems in order to remove airborne pathogens. The number of air movements and thus power consumption could be reduced with the employment of this technology.

Asset Utilisation Improvement – with the reduction of intra-day and intra-species cleaning through intermittent traditional hot water interventions, production line utilisation will be increased thereby providing higher levels of operational efficiencies and increased capacity.

- vi.Continuous sanitisation The benefit of this system is the fact that the production surfaces are sanitised throughout the entire process as opposed to the unreliability of intermittent water sanitisation.
- vii.First industrial applications in Australia –New breakthrough in Active PCO technology enabling effective microbial load reduction in both indoor air and surfaces. Limited application expertise in food and red meat processing.
- viii.Maintenance Low cost of ownership and maintenance.
- ix.Health and Safety Continuous risk reduction from infectious pathogens in the workplace environment will reduce absenteeism caused by associated sickness, maintaining production efficiencies.
- x.Shelf-life extension red meat processing use of Active PCO technology to maintain and possibly enhance Australia's exemplar shelf-life through continuous reduction of surface microbial loads in red meat processing environments despite reduction of traditional cleaning methods.

The expected outcomes of the project will be to provide insights and practical knowledge on how this publicly available technology can be applied to benefit red meat production operations across the whole value chain. It is envisaged that this may lead into further research aimed at incorporating the technology into MAP, Utilities, odour control in waste management, increased sanitation in HVAC and equipment cleaning applications to provide additional microbial reduction. The outcomes of this stage 1 validation in red meat processing will be applied to develop recommendations for adoption in red meat processing.

The project will provide insights and practical knowledge on how this publicly available technology can be applied to benefit red meat production operations across the whole value chain.

The proposed project will bring the technology to Australia for validation in a specific Stage 1 application in air and surface purification. It is envisaged that this may lead into further research aimed at incorporating the technology into MAP, Utilities, odour control in waste management, increased sanitation in HVAC and equipment cleaning applications to provide additional microbial reduction.

#### Further R&D may include:

- The project will provide insights and practical knowledge on how this publicly available technology can be applied to benefit red meat production operations across the whole value chain.
- Shelf-life extension red meat retail a reduced surface microbial load on red meat deli products in the retail environment may produce shelf-life extension
- Customer market analysis associated with elimination of odours in the retail environment associated with fresh products, particularly seafood in the deli sections, enhancing customer perceptions of freshness.
- Customer market analysis customer perceptions associated with COVID-19 safe production facilities and products with possible development of premium product lines.
- Export market Research the effects of Active PCO technology on primals with possible impact on the good lactic acid bacteria
- Transportation Although primals are vacuumed sealed and packed in crates, leaving minimal exposed surfaces, it would be prudent to investigate the impacts of limiting microbial loads on the packaging surfaces during transportation which could be introduced into processing facilities. Likewise sanitation of transport from processing to retail would be beneficial to avoid introducing contamination into retail environments.
- Further research aimed at incorporating the technology into MAP, Utilities, odour control in waste management, increased sanitation in HVAC and equipment cleaning applications to provide additional microbial reduction.
- Investigating the benefits to worker health through introduction of Puradigm units in work environments and collecting data on absenteeism reductions due to reductions in person to person transmission of viruses or bacteria such as flu, cold and gastro pathogens.

The overall roadmap of the project is as follows:

Milestone 1 will develop the detailed test schedules for the overall project, including Chef Fresh packaging decontamination, RROA HVAC pathogen reductions and RROA shelf-life extension trials.

Milestone 2 will focus on evaluating the technology in real-world settings against standard microbiological pathogens expected in the Chef Fresh packaging material decontamination rooms (old ozone rooms).

Milestone 3 will focus on evaluating the technology in real-world settings within the RROA facility, testing against standard microbiological pathogens found in the air and on surfaces of the HVAC environments.

Milestone 4 will evaluate the technology to investigate shelf life extension of food products and enhancing food safety trust.

Milestone 5 is the final report detailing the outcomes of the packaging decontamination, shelf life extension, HVAC microbiological reduction and shelf life extension in combination with Denba.

# 3 Milestone Outcomes

#### 3.1 Milestone 1

Milestone 1 focuses on the development of the test schedule for the project. The project is divided into 3 main sections:

- 1. Packaging Decontamination
- 2. HVAC Pathogen Reduction
- 3. Shelf-Life Extension

A project steering committee has been formed to manage and execute the project. The members are formed from staff from Technical, Engineering and the Senior Leadership Team.

**Project Steering Committee:** 

Patrick Youil:	Team Leader
Suvir Salins:	Project Manager
Sheetal Maharaj:	Technical/Quality Manager
George Salloum:	Site Manager
Justin Meehan:	Chef Fresh Engineering

#### 3.2 Test Schedule – Packaging Decontamination Room

Currently at the Chef Fresh site ozone rooms are being utilised to disinfect the outer packaging material of tray packages. While the trays are kept sterilised within the packages, the outer material can't be guaranteed to be sterile before being opened, and thus ozone was being used to perform the disinfection.

#### 3.2.1 Test Schedule – Packaging Decontamination Room - Safety

Ozone is not safe at levels above 0.1 ppm for more than 6.6hrs according to safe work Australia and EPA safety standards. These high levels of ozone can cause lung or eye damage. However, to be sufficiently anti-pathogenic, levels of ozone above 1ppm are required which are even more dangerous.

Levels measured with an ultra-low ozone sensor show that the current ozone room is generating dangerous levels of ozone.



To control the safety and protect staff, safety doors were used to control the entry of personnel into the ozone room in such a way as to only allow access when the room had been purged of ozone. Lower levels of ozone (0.1ppm) were utilised over longer periods of time in order to retain efficacy while further enhancing safety.

Puradigm presents an alternative to the use of harmful ozone. Puradigm can inactivate viruses and destroy bacteria on surfaces remote to the device, without requiring the air to be brought back to the device for treatment. Devices which simply treat the air can't sufficiently treat the surfaces of objects. Puradigm's unique capability of producing long lasting, safe, charged water vapour ie water droplets covered with protons and electrons, which is a non-thermal plasma (NTP), and can treat both the air and surfaces within a large volume of space, is the perfect alternative.

Puradigm Zone 100s installed in the Ozone Room



Using Puradigm - Ozone well within safety limits, NTP at levels over 123k ions/cm3



3.2.2 Test Schedule – Packaging Decontamination Room – Test Method

The test protocol to be used to validate the efficacy of the Puradigm units in pathogen reduction of the packaging material, will utilise ATP testers to check the cleanliness of the packaging material before and after exposure to the Puradigm technology within the packaging decontamination room.

ATP testers measure Adenosine triphosphate, which is the energy molecule of all living organisms. Using an enzyme derived from fire flies a chemical reaction is utilised to generate photons of light if ATP is present. The number of photons generated is directly proportional to the amount of ATP present.



The ATP Tester generates a result measured in Relative Light Unit (RLU). The higher the RLU the dirtier the surface being tested.



Packaging outer material will be swabbed with the ATP UltraSnap swab.



The UltraSnap swab is wiped across the material in a grid pattern vertically and horizontally. The swab is placed back in the holder, snapped to activate and then squeezed to deliver the enzyme to the swab.



The swab is then placed into the testing unit.



If the RLU result is less than 20 the material is clean, a green result. If the result is between 20-60 RLU the material is moderately unclean, an orange result. If the RLU is greater than 60 the material is dirty, a red result.

Baseline measurement of the packaging material before exposure



Measurement of the packaging material after exposure

Packaging Trial 1 Baseline

Ozone Room

#### 3.2.3 Test Schedule – Packaging Decontamination Room – Test Schedule



Place four packages in four locations around the room.

Measure the ATP on packages before and after 8hours of Puradigm exposure for all four packages.

Trial	Packaging 1 Result	Packaging 2 Result	Packaging 3 Result	Packaging 4 Result
	(RLU)	(RLU)	(RLU)	(RLU)
1 – Baseline				
Before Exposure				
1 – After 8hr				
Puradigm Exposure				
2 – Baseline				
Before Exposure				
2 – After 8hr				
Puradigm Exposure				
3 – Baseline				
Before Exposure				
3 – After 8hr				
Puradigm Exposure				

Record results in the table below for 3 separate trials.

Based on results above the position of packaging may need to be altered to get better results, or the units themselves may need to be lowered, or possibly stronger units, such as the PRO, may need to be trialled.

Repeat trials above for each change.

#### **3.3** Test Schedule – HVAC

The Coles Retail Ready Operations Australia manufacturing facility utilises Air Handling Units (AHU) to maintain cold chain compliance within the facility. The units circulate air through heat exchangers, down to the plant via air socks and then back via return air vents. During washdown periods at the end of each day significant hot water is used which generates large quantities of steam. During this period the AHUs are switched to a normally ventilated mode which brings in fresh air from outside. This process allows mould spores into the facility. Coupled with the organic material flowing in from the plant, the moisture and mould spores create a mould problem within each AHU.



3.3.1 Test Schedule – HVAC – Safety

Chronic coughing and sneezing, irritation to the eyes, mucus membranes of the nose and throat, rashes, chronic fatigue and persistent headaches can all be symptomatic of black mould exposure or black mould poisoning. Currently hygiene staff use harsh chemicals to clean AHU surfaces and to treat the coils to maintain their cleanliness. Despite these treatments, mould outbreaks continue to occur over a 1-3 month period.

Puradigm represents a safe alternative to the use of harsh chemical cleaners. No harmful ozone, hydrogen peroxide or volatile organic compounds are generated by Puradigm technology as compared to other Photo-Catalytic Oxidation (PCO) technology. Only a safe non-thermal plasma (NTP) is generated, which is a safe product that is naturally produced in outdoor environments as the sun's UV rays interact with the ambient moisture in the air.

#### 3.3.2 Test Schedule – HVAC – Test Method

Prior to the testing phase, the Hygiene team will wash down the walls within the RR11 AHU. RROA Technical team will then take air plates and swabs of supply locations within RR11 AHU5 as a baseline. At least 10 locations within the AHU will be tested, walls, floor, ceiling and coils.





The Puradigm HVAC units will be mounted through the ceiling of the AHU and will treat the air flowing through them as shown below.

#### 3.3.3 Test Schedule – HVAC – Test Schedule

The Puradigm units will be activated once the AHU has been cleaned and baseline readings have been taken. Samples of air plates and swabs will then be taken at the 1 week, 1 month, 2 month and 3 month points after the initial activation of the units.

If results do not show at least a 1-3 log reduction in pathogen counts, the units may be moved around in the AHU or additional units may be installed and then test process repeated for each change.

#### 3.4 Test Schedule – Shelf-Life

Coles RROA periodically check the shelf-life of primals received from our primary processing partners. Primals are debagged and swabbed to measure the total plate count (TPC) ie total microbiological counts on the surface of the primals. Primals are also left bagged and tested at certain periods up to 90 days.

Most primals are fairly clean with TPC under 1000 for freshly received product. This value can exceed 100s of millions of counts at the end of the shelf life period ie at 90 days.

Any reduction in TPC in the early stages of a primal's life can make significant impact on the overall shelf life of the product. Furthermore if micro contamination can be minimised, as a product is handled through the secondary processing phases within the RROA facility, additional shelf life extension can be achieved beyond current levels.

#### 3.4.1 Test Schedule – Shelf-Life – Safety

Puradigm technology is registered for use in organic agriculture in the US (Appendix 2 – Certifications), but in essence it doesn't need certification to be regarded as organic since it doesn't rely on chemicals to purify, but rather just a charged water aerosol, with trace amounts of ozone and hydrogen peroxide which then gets consumed by the catalytic process (Appendix 2 – Certifications). This technology does not produce any harmful or artificial substances. The NTP is a naturally occurring substance in outdoor environments that all organisms encounter and benefit from. Thus this technology is totally safe for humans, pets and plants and of course also safe for food manufacturing facilities.

Food product, including red meat, will be exposed to the Puradigm device's output, the NTP. All exposed surfaces of the food product will experience reductions in microbial counts only on the surface, not internally. The NTP, being comprised of charged molecules, can't penetrate the surface of multi-cellular organisms due to the chemical and structural nature of the cell membrane.

The Puradigm PRO is the largest Puradigm purifier delivering 2,200 billion NTP clusters/min. With a stainless steel form factor, this device is suitable for use in food grade environments.



#### 3.4.2 Test Schedule – Shelf-Life – Test Method

#### **Static Tests**

The validation testing will be conducted in the RROA Retention Room used by the Technical/Quality team.

There are no daily washdowns performed in this area, making it suitable for the Puradigm device without a splash guard. During the twice monthly general cleans, the portable devices will be removed from the room and brought back in after the cleaning is complete.

Primals will be placed on a tray, possibly with a mesh floor to allow treatment from the Puradigm device on the top and bottom of the primal surfaces.

Avoid primals stacked on top of one another, or too close to each other as shown below, as this will block NTP clusters from contacting surfaces which are occluded by adjoining primals.



Swabs will be taken from each primal at intervals and total plate counts measured by lab partners.

The expectation is to achieve 2-4 log reductions in surface microbiology counts after several minutes ie 99% to 99.99% reduction in bacterial counts.



#### **Dynamic Production Tests**

If the static tests are successful and achieve the desired log reduction of surface micro counts, as detailed above, production trials with primals being transferred along conveyors, will be conducted.

Puradigm units will be placed strategically along conveyor sections in order to maximise the time primals are exposed to the NTP clusters.

Swabs will be taken of treated primals to determine what log reductions can be achieved.



#### 3.4.3 Test Schedule – Shelf-Life – Test Schedule

Static Trials – long	Primal 1 Result	Conveyor exposed	Conveyor exposed	Conveyor control
exposures	(TPC)	to primal – 1 (TPC)	to primal – 2 (TPC)	(TPC)
1 – Baseline				
Before Exposure				
1 – After 15 mins				
Puradigm Exposure				
1 – After 2 hrs				
Puradigm Exposure				
1 – After 8hrs				
Puradigm Exposure				

#### Long Exposure trial – Primal and Conveyor surfaces

If the long exposure trials are successful, then proceed to short exposure trials.

#### Short Exposure trial – primal surfaces

Static Trials – short	Primal 1 Result	Primal 2 Result	Primal 3 Result	Primal 4 Result
exposures	(TPC)	(TPC)	(TPC)	(TPC)
2 – Baseline				
Before Exposure				
2 – After 1 min				
Puradigm Exposure				
2 – After 2 min				
Puradigm Exposure				
2 – After 5 min				
Puradigm Exposure				
2 – After 10 min				
Puradigm Exposure				
2 – After 15 min				
Puradigm Exposure				

Static Trials – short	Primal 1 Result	Conveyor exposed	Conveyor exposed	Conveyor control
exposures	(TPC)	to primal – 1 (TPC)	to primal – 2 (TPC)	(TPC)
2 – Baseline				
Before Exposure				
2 – After 1 min				
Puradigm Exposure				
2 – After 2 mins				
Puradigm Exposure				
2 – After 5 mins				
Puradigm Exposure				
2 – After 10 mins				
Puradigm Exposure				
2 – After 15 mins				
Puradigm Exposure				

#### Short Exposure trial – conveyor surfaces

Repeat trial with various orientations and distances of PROs relative to the primals, to determine minimum exposure time required and maximum effective distance between PRO and primal.

Use results from static tests to determine ideal positions of Puradigm units around the production line, to maximise exposure time and reduction effect on primals travelling on the conveyor, for the dynamic tests.

Swab primals before they are placed on the conveyor and then after they exit the conveyor section which is being treated by the Puradigm devices.

Dynamic Trials	Primal 1 Result (TPC)	Primal 2 Result (TPC)	Primal 3 Result (TPC)	Primal 4 Result (TPC)
1 – Baseline				
Before Exposure				
1 – After Puradigm				
Exposure				

Repeat the above with various orientations and distances of units around the conveyor until optimum results are achieved.

# 4 Milestone 2

Milestone 2 focuses on the implementation through practical trials and initial testing in a production environment, including:

- Analysis of environmental conditions and design to maximise Ion efficiencies in new and old ozone rooms
- Microbiological reductions on packaging material within old ozone rooms

#### 4.1 Packaging Decontamination Room – Analysis of Environmental Conditions

The Non-thermal plasma, charged water vapour, that the Puradigm units produce are generated at concentrations of 2 million/cm3. To be effective concentrations of 5K/cm<sup>3</sup> are required.

Ion concentrations were measured around the ozone room at various heights. The concentration was an average 20K/cm<sup>3</sup> at 1m high, increasing to 35-40K/cm<sup>3</sup> at 2m high. It was decided to reduce the height of the higher unit to the same level as the unit on the opposite wall to increase the concentration at lower levels which is where the majority of the packaging will be located.



After the unit was moved, the ion concentration readings increased to 30-50K/cm<sup>3</sup> at the bench level



#### **4.2** Packaging Decontamination Room – Microbiological Reductions

The QA department at Chef Fresh worked with their laboratory partners to design a test plan to measure the microbiological reductions on the packaging material. It was felt, that although ATP monitors could be used during ongoing spot checks, when the system is transitioned to full production, the trial would be best suited to standard micro swabs which are sent to the lab for analysis.

The packaging material is generally quite clean and so no dramatic changes would be seen using ATP. As such the testing protocol will include the inoculation of the test surfaces with a known concentration of microbiological contaminant and then test at various intervals to measure any reductions.

#### 4.2.1 Packaging Decontamination Test Protocol

- 1. Inoculate 1ml of 10<sup>6</sup> concentration of coagulase positive staphylococcus onto a sterilised, blank petri dish
- 2. Baseline measurement: Swab petri dish and obtain recovered count. Count is to be used as a baseline for the log reductions
- 3. Inoculate 6 petri dishes with 1ml of inoculum
- 4. Place the 6 petri dishes x 2 on the test bench in the ozone room
- 5. At various time intervals swab the petri dishes associated with that time period in both the test room and control area, and store swabs in the WIP freezer for lab pick up and analysis
- 6. Lab will incubate swabs and determine the count of each petri dish to measure the reduction relative to the control samples
- 7. Deduct the baseline count from each petri dish count to determine the log reduction for that time point
- Petri Dish 0: Blank dish 0 hour
- Petri Dish 1: Expose 1 hour
- Petri Dish 2: Expose 3 hours
- Petri Dish 3: Expose 5 hours
- Petri Dish 4: Expose 8 hours
- Petri Dish 5: Expose 12 hours
- Petri Dish 6: Expose 24 hours



Inoculating the test samples in duplicate for each time period T0, T1, T3, T5, T8, T12, T24



*Ion concentration and ozone measurements during the trial* 

Unfortunately despite controlling the access to the room quite strictly, at various points through the day, material had to be moved through the room several times. The result was a noticeable drop in ion concentration from 30-50k/cm<sup>3</sup> down to 15-20K/cm<sup>3</sup> which would have slowed reductions down.

Ozone levels stayed well within safety limits and also played very little role in reductions staying in the 0.008ppm – 0.014ppm which are the same as outdoor ambient conditions (note safe levels are <0.05ppm, with dangerous levels above 0.1ppm according to Australian Safety Standards).





#### 4.2.2 Packaging Decontamination Test Results

Unfortunately the lab made a mistake in their preparation of the test samples. The critical step of drying the staph inoculum onto the surface of the petri dishes was not done. 1ml solution represented a lot of liquid which both fed the pathogen as well as protected it from the active output of the Puradigm devices. Other technologies such as ozone will not penetrate a liquid barrier either.

The results of the lab analysis confirmed expectations with counts of staph increasing in both the test and control samples between the baseline at T=0hrs and T=24hrs. However it should be noted that at T=24hrs the test samples were 59-70% lower than the control samples for the same time point.

The reductions between test and control at T=24hrs can be explained by some of the staph migrating to the surface of the liquid which allowed the non-thermal plasma to deactivate the staph.

The experiment will have to be repeated but this time with all test and control samples being dried prior to the test starting. Using a 0.1mL solution will aid this drying process.

# Table showing actual microbiological counts for time periods T0, T1, T3, T5, T8, T12, T24 in duplicate

			Sa	mple				FM0023		
-	Sample No. 🔻	Overall Description		Sample Details 🕆	Status 🔻	Received -	Certificate Issued D 👻	- Coag Pos 🔻	<b>Reductions against TO</b>	<b>Reductions Test vs Control</b>
FS2243308-033 (1)	FS2243308-033	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm Bla	Completed	2022-08-04	2022-08-15	<10		
FS2243308-032 (1)	FS2243308-032	Preliminary Puradigm Unit Verification Study	-	Paradigm Blank	Completed	2022-08-04	2022-08-15	<10		
FS2243308-031 (1)	FS2243308-031	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm T2	Completed	2022-08-04	2022-08-15	3,100,000	-107%	
FS2243308-030 (1)	FS2243308-030	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm T2	Completed	2022-08-04	2022-08-15	3,800,000	-124%	
FS2243308-029 (1)	FS2243308-029	Preliminary Puradigm Unit Verification Study	-	Paradigm T24	Completed	2022-08-04	2022-08-15	2,800,000	-65%	59%
FS2243308-028 (1)	FS2243308-028	Preliminary Puradigm Unit Verification Study	-	Paradigm T24	Completed	2022-08-04	2022-08-15	1,700,000	15%	70%
FS2243308-027 (1)	FS2243308-027	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm T1	Completed	2022-08-04	2022-08-15	2,000,000	-18%	
FS2243308-026 (1)	FS2243308-026	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm T1	Completed	2022-08-04	2022-08-15	1,500,000	0%	
FS2243308-025 (1)	FS2243308-025	Preliminary Puradigm Unit Verification Study	-	Paradigm T12	Completed	2022-08-04	2022-08-15	1,500,000	25%	0%
FS2243308-024 (1)	FS2243308-024	Preliminary Puradigm Unit Verification Study	-	Paradigm T12	Completed	2022-08-04	2022-08-15	2,900,000	-71%	-53%
FS2243308-023 (1)	FS2243308-023	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm T8	Completed	2022-08-04	2022-08-15	1,400,000	7%	
FS2243308-022 (1)	FS2243308-022	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm T8	Completed	2022-08-04	2022-08-15	1,900,000	-12%	
FS2243308-021 (1)	FS2243308-021	Preliminary Puradigm Unit Verification Study	-	Paradigm T8	Completed	2022-08-04	2022-08-15	1,300,000	35%	5%
FS2243308-020 (1)	FS2243308-020	Preliminary Puradigm Unit Verification Study	-	Paradigm T8	Completed	2022-08-04	2022-08-15	1,900,000	-12%	0%
FS2243308-019 (1)	FS2243308-019	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm T5	Completed	2022-08-04	2022-08-15	1,400,000	7%	
FS2243308-018 (1)	FS2243308-018	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm T5	Completed	2022-08-04	2022-08-15	1,900,000	-12%	
FS2243308-017 (1)	FS2243308-017	Preliminary Puradigm Unit Verification Study	-	Paradigm T5	Completed	2022-08-04	2022-08-15	1,800,000	-6%	6%
FS2243308-016 (1)	FS2243308-016	Preliminary Puradigm Unit Verification Study	-	Paradigm T5	Completed	2022-08-04	2022-08-15	1,400,000	30%	0%
FS2243308-015 (1)	FS2243308-015	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm T3	Completed	2022-08-04	2022-08-15	1,900,000	-12%	
FS2243308-014 (1)	FS2243308-014	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm T3	Completed	2022-08-04	2022-08-15	1,500,000	0%	
FS2243308-013 (1)	FS2243308-013	Preliminary Puradigm Unit Verification Study	-	Paradigm T3	Completed	2022-08-04	2022-08-15	1,800,000	10%	-15%
FS2243308-012 (1)	FS2243308-012	Preliminary Puradigm Unit Verification Study	-	Paradigm T3	Completed	2022-08-04	2022-08-15	2,300,000	-35%	-24%
FS2243308-011 (1)	FS2243308-011	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm T1	Completed	2022-08-04	2022-08-15	2,700,000	-59%	
FS2243308-010 (1)	FS2243308-010	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm T1	Completed	2022-08-04	2022-08-15	2,100,000	-40%	
FS2243308-009 (1)	FS2243308-009	Preliminary Puradigm Unit Verification Study	-	Paradigm T1	Completed	2022-08-04	2022-08-15	2,800,000	-40%	-5%
FS2243308-008 (1)	FS2243308-008	Preliminary Puradigm Unit Verification Study	-	Paradigm T1	Completed	2022-08-04	2022-08-15	2,200,000	-29%	-6%
FS2243308-007 (1)	FS2243308-007	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm T0	Completed	2022-08-04	2022-08-15	1,700,000	Baseline	
FS2243308-006 (1)	FS2243308-006	Preliminary Puradigm Unit Verification Study	-	Non-Paradigm T0	Completed	2022-08-04	2022-08-15	1,500,000	Baseline	
FS2243308-005 (1)	FS2243308-005	Preliminary Puradigm Unit Verification Study	-	Paradigm T0	Completed	2022-08-04	2022-08-15	1,700,000	Baseline	
FS2243308-004 (1)	FS2243308-004	Preliminary Puradigm Unit Verification Study	-	Paradigm TO	Completed	2022-08-04	2022-08-15	2,000,000	Baseline	
FS2243308-003 (1)	FS2243308-003	Preliminary Puradigm Unit Verification Study	-	Innoculum level	Completed	2022-08-04	2022-08-15	2,000,000		
FS2243308-002 (1)	FS2243308-002	Preliminary Puradigm Unit Verification Study	-	Innoculum level	Completed	2022-08-04	2022-08-15	800,000		
FS2243308-001 (1)	FS2243308-001	Preliminary Puradigm Unit Verification Study	-	Innoculum level	Completed	2022-08-04	2022-08-15	1,400,000*		
# 4.3 HVAC Installation

In preparation for the upcoming trials within the Air Handling Units (AHUs), electrical services have been installed on the roof of the units as shown below.

Penetrations have then been cut into the roof of the AHUs and the HVAC 14" Puradigm Units installed.









# 4.4 Shelf-Life Room – Trial Preparation

In preparation for the upcoming trials within the QA Retention cool room, electrical GPOs have been installed as shown below.



# **4.5** Shelf-Life Room – Analysis of Environmental Conditions and 24hr Microbiological Reduction Trial

An initial trial on shelf-life extension was conducted in Milestone 2 in preparation for the production trials scheduled for Milestone 2. This trial was conducted in the QA Retention Chiller Room where samples are stored for analysis. The temperature of the room is 4°C. Note that the room's temperature increased to 5°C with 2 x Puradigm PROs running constantly in the room consuming 168W each. The room's temperature was dropped by 1°C to compensate and return ambient conditions to 4°C. There was also a *strong opposing air flow* which will *show if the Puradigm NTP can still have an effect in this real-world condition.* 

## 4.5.1 Shelf-Life 24hr Microbiological Reduction Test Protocol

- Use Outside flat primals aged in vac bags for 35 days. Expect 1 million total plate counts (TPC) at this age
- Baseline measurement: Cut open vac bags outside the retention room and take swabs of a 10cm x 10cm area of each primal after pat drying the surfaces with blue paper towelling to remove excess moisture, using FlexiSwabs (sponge swabs). Label swabs accordingly.
- 3. Move primals into the retention room which contains 2 x Puradigm PROs which have been running continuously for 1 week.
- 4. Place primals in the ordered they were swabbed on the rack that the Puradigm PROs are treating
- 5. Measure ion counts and ozone levels at T=0hrs
- 6. Measure ion counts and ozone levels at T=24hrs
- 7. Test measurement: Take swabs of a 10cm x 10cm area of each primal in the same order the baseline swabs were taken, using FlexiSwabs. Label T=24hrs and 1 to 4 for each primal.
- 8. Send to the ALS laboratory for analysis of TPC reductions measured over the 24hr period.

## 4.5.2 Shelf-Life 24hr Microbiological Reduction Test Results – Test 1



Check Ion Count (1000 ions/cm<sup>3</sup>) and Ozone levels (ppm) at T=0hrs Baseline (16<sup>th</sup> August, 2022)

It should be noted that due to very *dry conditions and low temperatures* these *ion counts are lower than usual*, with 500K-2million ions/cm<sup>3</sup> usual, not 100-200K ions/cm<sup>3</sup> at the outlet of each device.

The *ozone levels are well within safety levels* at 0.024ppm, and well below the 1ppm that ozone needs to reach before it starts reducing pathogens. Any *reductions* will thus only be *attributable to the non-thermal plasma (NTP) ie charged water aerosols.* 



Swabs at T=0hrs, Baseline, in 10cm x 10cm surface regions (16<sup>th</sup> August, 2022)

Swabs kept in the fridge for lab pick-up



Check Ion Count (1000 ions/cm<sup>3</sup>) and Ozone levels (ppm) at T=24hrs Baseline (17<sup>th</sup> August, 2022)



It was noted that one of the units seemed to be off with the power cable slightly loose. Possibly knocked by QA personnel passing through the room. However the other device was operating and ion and ozone levels were similar to the baseline levels.

Swabs at T=24hrs, in 10cm x 10cm surface regions (17 th August, 2022)



Swabs kept in the fridge for lab pick-up



## **ALS Laboratory Submission Form**

The laboratory will measure TPC at T=0hrs and T=24hrs for the 4 primal samples. Expecting 1 million TPCs at T=0hrs and a 2-4 log reduction at T=24hrs ie 99-99.99% reduction.

	FOOD MIC	ROBIOLO	OGY	-	SA	MP	LE S	SUB	MIS	SIO	N F	ORI	M							Office use only:		
		Company	Nan	ıe:	Reta	il Rea	ady O	pera	tions	Aust	tralia	ı										
		Contact Pe	erso	n:	Shee	tal M	lahar	aj												Date:		
Food Pharmace 10/2-8 South St Rydalr T:+61 2 8832 7500   F:-	eutical nere NSW 2116	Street Add	dres	s:	54 T	empl	ar Ro	oad E	rskin	ie Pai		Print & Email to ALS	Time: Condition:									
Office use of Affix ALS Workor		Email Add	lres	s:	Shee 0437			aj@co	oles.c	om.a			Opened by:									
		Phone:		_	0437			dian	1 24-	how	Log	Tria	lor	Prin	nal Q	urfa	o En	vire	nmontal FloviSwah			
Purchase Order No.	Purchase Order No. Speci						Puradigm 24-hour Log Trial on Primal Surface Environmental FlexiSwab T=0 (16/08/2022) T=24hr (17/08/2022)															
			-																			
Sample Name					Testing Required (please tick tests required)																	
Sample Name			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other (please specify)			
Sample 1. T=0				х																		
Sample 2. T=0				x																		
Sample 3. T=0				x																		
Sample 4. T=0				x																		
Sample 1. T=24h				x																		
Sample 2. T=24h				x																		
Sample 3. T=24h				x																		
Sample 4. T=24h				x																		
	rate report for		~ .												Fam	alact	to ho	com	posited:			

'lease enclose a hard copy of this completed form with the samples

Test	Test Description	Test	Test Description	Test	Test Description
No.	rest Beschiption	No.	rest beschiption	No.	1 cor Debel priori
1	Standard Plate Count - food and dairy	7	E.coli - PETRIFILM <10	13	Enterobacteriaceae Enumeration
2	Standard Plate Count - Raw Meat and Fish	8	Coliforms - PETRIFILM <10	14	Coagulase Positive Staph - Enumeration

#### **ALS Laboratory Microbiology Results**

# **ALS** Certificate of Analysis

Retail Ready Operations Australia Pty Ltd PO Box 97 St Clair NSW, 2759

#### Attention: Sheetal Maharaj

<b>Overall Description:</b>	Puradigm 24-hour Log Trial on Primal Surf	ace Environmental FlexiSwab - 17/08/2022
Our Ref No:	FS2246510	Your Ref:
Project:		Report Date: 24 Aug 2022
Samples Received:	17 Aug 2022	Temperature when received: 2.8
Testing Commenced:	17 Aug 2022	

This report cannot be reproduced except in full, without written approval from the laboratory. Samples tested as received into the laboratory, unless the sampling was conducted by ALS.

Sample Details: Test Description		Results	Units	Site
001 Sample 1. T=0 (16/08/2022) (NAT	A Accredited)			
FM0010	Aerobic Plate Count	>200,000	cfu/swab.	NSV
002 Sample 2. T=0(16/08/2022) (NAT	A Accredited)			
FM0010	Aerobic Plate Count	>200,000	cfu/swab.	NSV
003 Sample 3. T=0(16/08/2022) (NAT	A Accredited)			
FM0010	Aerobic Plate Count	>200,000	cfu/swab.	NSV
004 Sample 4. T=0(16/08/2022) (NAT	A Accredited)			
FM0010	Aerobic Plate Count	>200,000	cfu/swab.	NS/
005 Sample 1. T=24h(17/08/2022) (NA	TA Accredited)			
FM0010	Aerobic Plate Count	~28,000	cfu/swab.	NSV
006 Sample 2. T=24h(17/08/2022) (NA	ATA Accredited)			
FM0010	Aerobic Plate Count	>200,000	cfu/swab.	NSV
007 Sample 3. T=24h(17/08/2022) (NA	ATA Accredited)			
FM0010	Aerobic Plate Count	>200,000	cfu/swab.	NSV
008 Sample 4. T=24h(17/08/2022) (NA	ATA Accredited)			
FM0010	Aerobic Plate Count	~32,000	cfu/swab.	NSV

<sup>1</sup>NATA accreditation does not cover the performance of this service. Measurement of Uncertainty values for your compliance are available at https://www.alsglobal.com/au/services-and-products/food-safety/laboratory-downloads/client-downloads.

#### Signatories

Tran Tu	Laboratory Supervisor - Microbiology	Food Microbiology	
Signatories	Position	Accreditation Category	
	ronically signed by the authorized signatories i e with procedures specified in 21 CFR Part 11.	ndicated below. Electronic signing has	NATA
Signatories			

**General Comments** 

N/D = Not Detected, < = Less than, > = Greater than, cfu = colony forming unit, MPN = Most Probable Number, PN = Probable Number, Y = Yeast, M = Mould, ~ = Estimate

These tests are based on **35 day aged primals with very high pathogen loads** which are generally not the target product, but are being used to show how **this technology handles an extreme case**.

Primals 1 and 4 showed **at least an 86% and 84% reduction** in aerobic plate count for surface samples based on the T0 200,000 counts. Expected surface counts for primals at day 35 is expected to be 1,000,000+ counts, so the **actual reduction may be closer to 97.2% and 96.8% ie 2 log reduction.** 

A 2 log reduction is what is expected. However the primals which did not show a reduction, may have reduced from 1million+ to just above 200K, but the lab was not able to show those levels. The *next tests will be based on better count resolution to capture the true reduction amount*.

Additionally adding tubs of water to enhance humidity and moving the trial out of the direct air flow of the condenser fan may enhance the effectiveness of the Puradigm units. These will be trialled in the next milestone.

# 5 Milestone 3

Milestone 3 focuses on the implementation through practical trials and initial testing in a production environment, including:

- Analysis of environmental conditions and design to maximise Ion efficiencies in new and old ozone rooms
- Microbiological reductions on packaging material within old ozone rooms

# Install trial units in RROA production HVAC locations. Design production trial methodologies. Collect and analyse test samples, including:

- Microbiological reductions in air and on surfaces within the HVAC environment
- Microbiological reductions on conveyor or machine surfaces

### **Continue shelf-life trials**

• Microbiological reductions on the surface of primals

# 5.1 Shelf-Life Room – Analysis of Environmental Conditions and 24hr Microbiological Reduction Trial

A repeat trial on shelf-life extension was conducted in Milestone 3 in preparation for the production trials scheduled for Milestone 4. This trial was conducted in the QA Retention Chiller Room where samples are stored for analysis. The temperature of **the room is 4°C**. This temperature is a **challenge for NTP production as the UV bulb generally like temperatures above 10°C**.

The previous trial showed that ion levels were lower than expected. As such a tub of water was introduced near the PROs to *enhance the humidity of the room*. The NTP production is related to the ambient humidity and as such levels were expected to be higher.

Negative ion levels in Test 1 of Milestone 2, were 80K ions/cm<sup>3</sup>. Measurements for Test 2 of Milestone 3 showed levels around 100-130K ions/cm<sup>3</sup> at the primals between T=0hrs and T=24hrs.

# The targets were 35 day aged primals with very high pathogenic loads to again show how the technology handles an extreme case.



# Test 2 24hr Microbiological Reduction – 1<sup>st</sup> September, 2022

# 5.1.1 Shelf-Life 24-96hr Microbiological Reductions Test Results – Test 2 & 3



Check Ion Count (1000 ions/cm<sup>3</sup>) and Ozone levels (ppm) at T=0hrs Baseline (1<sup>st</sup> September, 2022)

It should be noted that due to **very dry conditions and low temperatures these ion counts are lower** than usual, with 500K-2million ions/cm<sup>3</sup> usual, not 100-200K ions/cm<sup>3</sup> at the outlet of each device. However the levels have increased relative to Test 1 Milestone 2, most likely due to the addition of the tub of water to increase relative humidity levels.

The *ozone levels are well within safety levels* and well below the 1ppm that ozone needs to reach before it starts reducing pathogens. Any *reductions will thus only be attributable to the non-thermal plasma (NTP) ie charged water aerosols*.

Swabs at T=Ohrs, Baseline, in 10cm x 10cm surface regions (1<sup>st</sup> September, 2022)







Check Ion Count (1000 ions/cm<sup>3</sup>) and Ozone levels (ppm) at T=24hrs Baseline (2<sup>nd</sup> September, 2022)



Ion levels showed improvement with the use of the tub of water enhancing the humidity of the air.



The setup was still in the direct path of the *opposing, high speed air flow* from the condenser fan which would be blowing ions away from primals 3 and 4 from the second PRO unit, while primals 1 and 2 are downstream from the fist PRO unit which is blowing ions in the same direction as the room's condenser fan.

*Ozone levels were still low* relative to safety standards and the ability of ozone to reduce pathogens, ensuring that any *reductions seen would be solely due to the NTPs*.

Swabs at T=24hrs, in 10cm x 10cm surface regions (2<sup>nd</sup> September, 2022)





## ALS Laboratory Submission Form – Test 2 – 24hrs

The laboratory will measure TPC at T=24hrs for the 4 primal samples. Used a dilution factor of 1:10 (limit of test <10 cfu/swab) to ensure we get closer to the true counts.

	FOOD MIC	ROBIOLC	)GY	-	SA	MP	LE S	SUB	MIS	SIO	N F	ORN	1							Office use only:
		Company	Nam	ie:	Reta	l Rea	dy O	pera	tions	Aust	ralia									
		Contact P	erso	n:	Shee	tal M	ahar	aj												Date:
Food Pharmace 10/2-8 South St Rydaln T: +61 2 8832 7500   F: +	nere NSW 2116	Street Add	s:	54 T	empl	ar Ro	ad E	rskin	ie Pai		Print & Email to ALS	Time: Condition:								
Office use or Affix ALS Workor	ıly: der label	Email Add	lress	8:	Shee	tal.M	ahara	aj@co	oles.c	om.a			Opened by:							
		Phone:			0437	967 5	91													
Purchase Order No.	02/09/2022			ecia stru	ial uctions: T=0 (01/09/2022) T=24hr (02/09/2022)															
Sample Name					Testing Required (please tick tests required)															
Sample Name														12	13	14				
			1	2	3	4	5	6	7	8	9	10	11	12	15	14	15	16	Other (ple	ase specify)
Sample 1. T=0			1	2 X	3	4	5	6	7	8	9	10	11	12	15	14	15	16	Other (ple	ase specify}
Sample 1. T=0 Sample 2. T=0			1		3	4	5	6	7	8	9	10	11	12	15	14	15	16	Other (ple	ase specify)
•			1	x	3	4	5	6	7	8	9	10	11	12	15	14	15	16	Other (ple	ase specify)
Sample 2. T=0			1	x x	3	4	5	6	7	8	9	10	11	12	15	14	15	16	Other (ple	ase specify)
Sample 2. T=0 Sample 3. T=0				x x x	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other (ple	ase specify)
Sample 2. T=0 Sample 3. T=0 Sample 4. T=0				X X X x	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other (ple	ase specify)
Sample 2. T=0 Sample 3. T=0 Sample 4. T=0 Sample 1. T=24h				X X X x x	3	4	5	6	7	8	9	10	11		13		15	16	Other (ple	ase specify)
Sample 2. T=0 Sample 3. T=0 Sample 4. T=0 Sample 1. T=24h Sample 2. T=24h				X X X x x x	3	4	5	6	7	8	9	10	11					16	Other (ple	ase specify)
Sample 2. T=0 Sample 3. T=0 Sample 4. T=0 Sample 1. T=24h Sample 2. T=24h Sample 3. T=24h				X X X x x x x x	3	4	5	6	7	8	9	10	11					16	Other (ple	ase specify)
Sample 2. T=0 Sample 3. T=0 Sample 4. T=0 Sample 1. T=24h Sample 2. T=24h Sample 3. T=24h				X X X x x x x x	3	4	5	6	7	8	9							16		ase specify)

#### ALS Laboratory Microbiology Results - Test 2 - 24hrs



Retail Ready Operations Australia Pty Ltd PO Box 97 St Clair NSW, 2759

#### Attention: Sheetal Maharaj

<b>Overall Description:</b>	Puradigm 24-hour Log Trial on Primal Surf	ace Environmental FlexiSwab - 02/09/2022
Our Ref No:	FS2250055	Your Ref:
Project:		Report Date: 07 Sep 2022
Samples Received:	02 Sep 2022	Temperature when received: 3.1
Testing Commenced:	02 Sep 2022	

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Sample Details: Test Description		Results	Units	Site
001 Sample 1. T=0 (NAT)	A Accredited)			
FM0010	Aerobic Plate Count	~50,000	cfu/swab.	NSW
002 Sample 2. T=0 (NAT)	A Accredited)			
FM0010	Aerobic Plate Count	4,800	cfu/swab.	NSW
003 Sample 3. T=0 (NAT)	A Accredited)			
FM0010	Aerobic Plate Count	~50,000	cfu/swab.	NSW
004 Sample 4. T=0 (NAT)	A Accredited)			
FM0010	Aerobic Plate Count	~56,000	cfu/swab.	NSW
005 Sample 1. T=24h (NA	ATA Accredited)			
FM0010	Aerobic Plate Count	2,700	cfu/swab.	NSW
006 Sample 2. T=24h (NA	ATA Accredited)			
FM0010	Aerobic Plate Count	4,500	cfu/swab.	NSW
007 Sample 3. T=24h (NA	ATA Accredited)			
FM0010	Aerobic Plate Count	1,900	cfu/swab.	NSW
008 Sample 4. T=24h (NA	ATA Accredited)			
FM0010	Aerobic Plate Count	540	cfu/swab.	NSW

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#### Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Jason Alvarez	Laboratory Manager	Food Microbiology



Using the 10:1 dilution factor instead of the 1000:1 dilution factor used in Test 1 allowed a more accurate T=24hr relative to T=0hr count to be measured. The results clearly showed 2 log reductions in surface counts. Primals 1, 3 & 4 showed 95%, 96% and 99% reduction in aerobic plate count for surface samples based on the T0 50,000, 50,000 and 56,000 counts respectively. Primal 2 showed an anomalous T0 count of only 4,800 with a final count of 4,500 which is only a 6.25% reduction. If Primal 2's T0 count was 50,000, its reduction would have been 91%. Possibly the T0 swab was not thorough.





### ALS Laboratory Submission Form – Test 3 – 96hrs

The laboratory will measure TPC at T=96hrs for the 4 primal samples. Used a dilution factor of 1:10 (limit of test <10 cfu/swab) to ensure we get closer to the true counts should any counts be very high, however expecting the counts to be quite low at this stage.

	FOOD MIC	ROBIOLO	GY -	SAM	PLE SUBMISSION FORM		Office use only:
		Company l	Name:	Retail R	eady Operations Australia		
		Contact Pe	rson:	Sheetal	Maharaj		Date:
Food Pharmace 10/2-8 South St Rydair T: +61 2 8832 7500   F: -	& eutical mere NSW 2116	Street Add	ress:	54 Tem	plar Road Erskine Park NSW 2759	Print & Email to ALS	Time: Condition:
Office use of Affix ALS Workor		Email Add	ress:	Sheetal.	Maharaj@coles.com.au		Opened by:
		Phone:		0437 967	591		
Purchase Order No.	05/09/2022		Speci Instru	al uctions:	Puradigm 24-hour Log Trial on Primal Surface Envir Separate invoice for this test. Limit of the tests as <10 cfu/swab T=96h (05/09/2022)	onmental FlexiSwab.	

Sample Name									Te	sting	g Req	uire	d (pl	ease	tick	test	s required)
Sample Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other (please specify)
Sample 1. T=96 h		х															
Sample 2. T=96h		x															
Sample 3. T=96h		x															
Sample 4. T=96h		x															

# Check Ion Count (1000 ions/cm<sup>3</sup>) and Ozone levels (ppm) at T=96hrs (5<sup>th</sup> September, 2022)





#### ALS Laboratory Microbiology Results - Test 3 - 96hrs



Retail Ready Operations Australia Pty Ltd PO Box 97 St Clair NSW, 2759

#### Attention: Sheetal Maharaj

Overall Description:	Puradigm 24-hour Log Trial on Primal Surf (05/09/2022)- 06/09/2022	ace Environmental FlexiSwab. T=96h
Our Ref No:	FS2250508	Your Ref: 05/09/2022
Project:		Report Date: 13 Sep 2022
Samples Received:	06 Sep 2022	Temperature when received: 3.2
Testing Commenced:	06 Sep 2022	

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Sample Details: Test Description	on	Results	Units	Site
001 Sample 1. T=96 h	(NATA Accredited)			
FM0010	Aerobic Plate Count	<10	cfu/swab.	NSW
002 Sample 2. T=96h (	NATA Accredited)			
FM0010	Aerobic Plate Count	130	cfu/swab.	NSW
003 Sample 3. T=96h (	NATA Accredited)			
FM0010	Aerobic Plate Count	<10	cfu/swab.	NSW
004 Sample 4. T=96h (	NATA Accredited)			
FM0010	Aerobic Plate Count	80	cfu/swab.	NSW

'NATA accreditation does not cover the performance of this service. Measurement of Uncertainty values for your compliance are available at https://www.alsglobal.com/au/services-and-products/food-safety/laboratory-downloads/client-downloa

#### Signatories

Jason Alvarez	Laboratory Manager	Food Microbiology	WORLD RECOGNISED
Signatories	Position	Accreditation Category	
	ctronically signed by the authorized signa ce with procedures specified in 21 CFR P	atories indicated below. Electronic signing has art 11.	NATA

General Comments

N/D = Not Detected, < = Less than, > = Greater than, cfu = colony forming unit, MPN = Most Probable Number, PN = Probable Number, Y = Yeast, M = Mould, ~ = Estimate

Primals 1 & 3 had counts below the level of detection ie <10 cfu/swab, while primals 2&4 were very low. Log reductions from the baseline counts were as follows:

Primal 1: 50000 down to <10 is >99.98% reduction ie >4 log

Primal 2: 4800 down to 130 is >97.29% reduction ie >2 log (If T0 was 50000 then reduction is >99.74%)

Primal 3: 50000 down to <10 is >99.98% reduction ie >4 log

Primal 4: 56000 down to 80 is >99.86% reduction ie >3 log

redited for compliance v ISO/IEC 17025 - Testing





The trial results show that despite the *challenge of a cold environment and an opposing, fast ambient air flow and extremely high pathogen loads from 35 day aged primals* this trial of *close proximity, long duration*, with some moisture in the air but a dry primal surface, produced results are as expected, ranging from 2 to 4 log reductions.

The trial has passed the first stage gate of one extreme.

The next trials will confirm that *shorter durations, greater distances and moist surfaces* also experience *significant reductions*.

## 5.1.2 Shelf-Life 24-144hr 2hourly Microbiological Reductions Test Results – Test 4

The next trial will focus on how quickly the reduction results are actually achieved, on *extreme pathogen loads using 35 day aged primals*, by conducting another 24hr trial and taking samples every 2hrs to see whether the *shorter exposure times* result in significant log reductions. This trial only used 2 primals with one end close (0.2m) to PRO 1 while the other end is 1.5m away from PRO 2 to see if there is a significant difference to reductions and time with distance. Furthermore it should be noted that the ends of the primal facing PRO 2 are at a *disadvantage being downstream from the strong air flow within the room*. Additionally sample point 3 does not see the peak of the non-thermal plasma (NTP) flow from PRO 2, while sample point 4 sees the peak NTP





# Check Ion Count (1000 ions/cm<sup>3</sup>) and Ozone levels (ppm) at T=0hrs Baseline (11<sup>th</sup> October, 2022)

Swabs at T=0hrs, Baseline, in 10cm x 10cm surface regions (11<sup>th</sup> October, 2022)





## Swabs collected from 0 to 144hrs







# ALS Laboratory Submission Form – Test 4 – 0,2,4,6,8, 24hrs, 72hrs & 144hrs

	FOOD MIC	ROBIOLO	GY -	SAM	PLE SUBMISSION FORM		Office use only:
		Company l	Name:	Retail R	eady Operations Australia		
		Contact Pe	erson:	Sheetal	Maharaj		Date:
Food Pharmace 10/2-8 South St Rydaln T: +61 2 8832 7500   F: +			lress:	54 Temj	plar Road Erskine Park NSW 2759	Print & Email to ALS	Time: Condition: Opened by:
			ress:		Maharaj@coles.com.au		
		Phone:		0437 967			
Purchase Order No.	11/10/2022		Specia Instru	al ıctions:	Puradigm 24-hour 2 hourly Reduction Trial on Prima Separate invoice for this test. Limit of the tests as <10 cfu/swab Date Start: 11/10/2022 (T=0) T=0hr (11/10/2022) T=24hrs (12/10/2022) T=72hrs (14/10/2022)		ental <u>FlexiSwab</u> ,

ample Name									Те	-							s required)
•	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other (please specify)
Sample 1. T=0hr		x															
Sample 2. T=0hr		x															
Sample 3. T=0hr		x															
Sample 4. T=0hr		x															
Sample 1. T=2hrs		x															
Sample 2. T=2hrs		x															
Sample 3. T=2hrs		х															
Sample 4. T=2hrs		x															
Sample 1. T=4hrs		х															
Sample 2. T=4hrs		х															
Sample 3. T=4hrs		х															
Sample 4. T=4hrs		x															
Sample 1. T=6hrs		X															
Sample 2. T=6hrs		x															
Sample 3. T=6hrs		х															
Sample 4. T=6hrs		x															
Sample 1. T=8hrs		х															
Sample 2. T=8hrs		X															
Sample 3. T=8hrs		x															
Sample 4. T=8hrs		x															
Sample 1. T=24hrs		х															
Sample 2. T=24hrs		x															
Sample 3. T=24hrs		x															
Sample 4. T=24hrs		x															

	FOOD MIC	ROBIOLO	GY -	SAM	PLE SUBMISSION FORM		Office use only:
		Company N	Name:	Retail R	eady Operations Australia		
		Contact Pe	rson:	Sheetal	Maharaj		Date:
CALS Food Pharmace 10/2-8 South St. Rydah T: +61 2 8832 7500   F: + Office use of	<b>S</b> <b>eutical</b> nere NSW 2116 61 2 9898 3472	Street Add	ress:	54 Tem	plar Road Erskine Park NSW 2759	Print & Email to ALS	Time: Condition: Opened by:
Affix ALS Workor		Email Add	ress:	Sheetal.	Maharaj@coles.com.au		
		Phone:		0437 967			
Purchase Order No.	14/10/2022		Specia Instru	al actions:	Puradigm 24-hour 2 hourly Reduction Trial on Prim. Limit of the tests as <10 cfu/swab Date Start: 11/10/2022 (T=0) T=0hr (11/10/2022) T=24hrs (12/10/2022) T=72hrs (14/10/2022)	al Surface Environmo	ental <u>FlexiSwa</u> b.

ample Name			Testing Required (please tick tests required)														
ample Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other (please specify)
Sample 1. T=72hrs		х															
Sample 2. T=72hrs		х															
Sample 3. T=72hrs		х															
Sample 4. T=72hrs		x															

	FOOD MIC	ROBIOLO	GY -	SAM	PLE SUBMISSION FORM		Office use only:
		Company N	lame:	Retail R	eady Operations Australia		
	Company I Contact Pe Contact Pe South St Rydalmere NSW 2116 8832 7500 [F:+61 2 9898 3472 Office use only: Mit ALS Worksder label			Sheetal	Maharaj		Date:
				54 Temj	plar Road Erskine Park NSW 2759	Print & Email to ALS	Time:
10/2-8 South St Rydaln	Pharmaceutical Street Addres   //2-8 South St Rydalmere NSW 2116 +61 2 8832 7500   F: +61 2 9898 3472		ress:				Condition:
							Opened by:
		Email Addr	ess:	Sheetal.	Maharaj@coles.com.au		
		Phone:		0437 967	591		
Purchase Order No.	17/10/2022		Speci: Instru	al actions:	Puradigm 24-hour 2 hourly Reduction Trial on Prima Limit of the tests as <10 cfu/swab Date Start: 11/10/2022 (T=0) T=144hrs (17/10/2022)	ıl Surface Environme	ental <u>FlexiSwab</u> .

Sample Name									Te	sting	Req	uire	d (pl	ease	tick	test	s required)
Sample Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other (please specify)
Sample 1. T=144hrs		х															
Sample 2. T=144hrs		x															
Sample 3. T=144hrs		x															
Sample 4. T=144hrs		x															
o you require a separate report for each sample: Sample									oles t	o be	com	posited:					

### ALS Laboratory Microbiology Results – Test 4 – 0,2,4,6,8, 24hrs, 72hrs & 144hrs

For these *extremely high pathogen loads on 35 day aged primals, short duration* periods showed *no log reductions* in total plate count (TPC). In fact the first *2-4 hours typically resulted in an increase* in TPC. The *4-8 hour period had a gradual decline* of around 1 log reduction.

There was a *power outage* of PRO 1 between 8-24hrs. This resulted in a *very large increase in TPC* for Sample points 1 and 2 which are the points very close to PRO 1. Sample 3 also experienced very significant increases in TPC during that period despite PRO 2 remaining on. Sample 3 is 1.5m away from PRO 2, but it is in a location which sees a minimum of non-thermal plasma (NTP) while Sample 4 is in line with the peak NTP flow. The room has a very strong air flow, from the condenser fans, which blow against the PRO 2's NTP, thus sample points 3 & 4 tend to receive less NTP than sample points 1 & 2. *This increase in TPC during the shutdown, shows that the low temperature, high air flow speed and low humidity were not aiding in log reductions, the only cause of reductions is the Puradigm NTP.* 

However *from the 24hr point, after power was resumed, till the 144hr point, 4-5 log reductions were experienced*, bringing the TPC down to very low amounts typically only seen after a solid 24hrs of uninterrupted NTP at close range.

It is clear from the results that there is still *significant log reductions on TPC experienced despite distance and strong counteracting room airflows*. However durations shorter than 4 hours under those *extreme conditions* do not show significant reductions, as it *takes time for the NTP* to work its way through the many layers of pathogens as the NTP works on the surface, *one molecular layer at a time*. With *normal pathogen loads it is expected reductions will be rapid*. The next trials will confirm this.

The recommendation would be to situate *Puradigm devices fairly close to target* objects for *very contaminated subjects*, and ensure the NTP is flowing with the room air flow rather than against it, or that air flow is at a minimum speed for *maximum speed reductions*. Puradigm devices can *handle very large spaces and will cause reductions, even for highly contaminated air and surfaces, but these will take longer*, the further the device is from the surface. For fresh product, which have *low pathogen loads*, the Puradigm device can be *situated at a distance and achieve fast reductions* given the charged water aerosol permeates the entire space.

Additionally *significant reductions* on all surfaces that the product is in contact with, will benefit greatly from the *Puradigm NTP technology*, as will surfaces such as *drains*, *conveyor* drive sections which are *infrequently accessed* which may harbour traces of trapped product and other areas which could *harbour pathogens*. US secondary processors have reported listeria outbreaks every 2 weeks have been reduced to none after 6 months of exposure. *Further trials should be conducted to confirm these long term exposure benefits*.

It should be noted that these high levels of TPC are several orders of magnitude greater than those typical of fresh primals which are processed in the plant. The primals that have been tested are 35-day aged primals, and so their TPC is unusually high. Shorter term exposures, below 2 hours, could result in beneficial reductions when the TPC count is at normal levels, as the NTP doesn't have to work its way through so many layers of bacteria.

Time (h)	Sample 1	Sample 2	Sample 3	Sample 4
0	160000	600000	340000	180000
2	220000	640000	4E+09	840000
4	360000	190000	2700000	350000
6	290000	280000	2300000	190000
8	260000	79000	4E+09	97000
24	1.4E+08	8.7E+07	6100000	16000
72	22000	60000	50000	12000
144	8400	1700	190000	220
Max Reduction	99.99%	99.998%	99.995%	99.97%
Reduction 0-8hrs	28%	88%	0%	88%
Reduction 24-72hrs	99.98%	99.93%	99.92%	98.57%
Reduction 24-144hrs	99.99%	99.998%	99.69%	99.97%

# Total Plate Counts at each sampling time period 0 – 144hrs



#### First 2-4 hours sees an increase in TPC. Moderate decrease from 4-8 hours. Interruption to power 8-24 hours saw a big increase except for Sample 4. 4-5 log reductions from 24-144hrs

Overall Description:	Puradigm 24-hour 2 hourly Reduction Trial -Received 12/10/22; Arrival Temp:2.8C	on Primal Surface Environmental FlexiSwab
Our Ref No:	FS2258092 Amendment 1	Your Ref: 11/10/2022
Project:		Report Date: 26 Oct 2022
Samples Received:	12 Oct 2022	Temperature when received: 2.8
Testing Commenced:	12 Oct 2022	

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ils: Test Description	Units	Site
ple 1. T=0 (NATA Accredi		_
	160,000 cfu/swab.	NSV
ple 2. T=0 (NATA Accredit		_
	500,000 cfu/swab.	NS\
ple 3. T=0 (NATA Accredit		
• • •	340,000 cfu/swab.	NS
ple 4. T=0 (NATA Accredit		_
	180.000 cfu/swab.	NS
ple 1. T=2h (NATA Accred		_
	220.000 cfu/swab.	NS
ple 2. T=2h (NATA Accred		1
	640.000 cfu/swab.	NS
ple 3. T=2h (NATA Accred		1=
<b></b>	000.000 cfu/swab.	NS
ple 4. T=2h (NATA Accred		1
<b>Pro -</b> (	340.000 cfu/swab.	NS
ple 1. T=4h (NATA Accred	,	1
	360,000 cfu/swab.	NS
ple 2. T=4h (NATA Accred		
	190.000 cfu/swab.	NS
ple 3. T=4h (NATA Accred	130,000 Cid/3wab.	
pie 5. 1-411 (INATA Accred	700.000 cfu/swab.	NS
ple 4. T=4h (NATA Accred	Clu/Swab.	
	350.000 cfu/swab.	NS
ple 1. T=6h (NATA Accred		
	290.000 cfu/swab.	NS
ple 2. T=6h (NATA Accred	interest of the structure.	
pie 2. 1-on (MATA Accied	290.000 ofu/owoh	NS
pie 2. 1=60 (NATA ACCred	280,000 cfu/swa	ıb.

015 Sample 3. T=6h (NATA A	Accredited)			
FM0010	Aerobic Plate Count	2,300,000	cfu/swab.	NSV
016 Sample 4. T=6h (NATA A	Accredited)			
FM0010	Aerobic Plate Count	190,000	cfu/swab.	NSV
017 Sample 1. T=8h (NATA A	Accredited)			
FM0010	Aerobic Plate Count	~260,000	cfu/swab.	NSV
018 Sample 2. T=8hrs (NATA	Accredited)			
FM0010	Aerobic Plate Count	79,000	cfu/swab.	NSV
019 Sample 3. T=8hrs (NATA	Accredited)			
FM0010	Aerobic Plate Count	~400,000,000	cfu/swab.	NSV
020 Sample 4. T=8hrs (NATA	Accredited)			
FM0010	Aerobic Plate Count	97,000	cfu/swab.	NSV
021 Sample 1. T=24hrs (NAT	A Accredited)			
FM0010	Aerobic Plate Count	140,000,000	cfu/swab.	NSV
022 Sample 2. T=24hrs (NAT	A Accredited)			
FM0010	Aerobic Plate Count	87,000,000	cfu/swab.	NSW
023 Sample 3. T=24hrs (NAT	A Accredited)			
FM0010	Aerobic Plate Count	61,000,000	cfu/swab.	NSV
024 Sample 4. T=24hrs (NAT	A Accredited)			
FM0010	Aerobic Plate Count	16.000	cfu/swab.	NSV

#### S Certificate of Analysis Retail Ready Operations Australia Pty Ltd PO Box 97 St Clair NSW, 2759 Attention: Sheetal Maharaj Overall Description: Puradigm 24-hour 2 hourly Reduction Trial on Primal Surface Environmental FlexiSwab. -Received: 14/10/2022 Our Ref No: FS2258810 Your Ref: 14/10/2022 Report Date: 19 Oct 2022 Project: 14 Oct 2022 Samples Received: Temperature when received: 2.8 14 Oct 2022 Testing Commenced: This report cannot be reproduced except in full, without written approval from the laboratory. Samples tested as received into the laboratory, unless the sampling was conducted by ALS. Sample Details: Test Description Results 001 Sample 1. T=72hrs (NATA Accredited) FM0010 Aerobic Plate Count 002 Sample 2. T=72hrs (NATA Accredited) FM0010 Aerobic Plate Count 003 Sample 3. T=72hrs (NATA Accredited) FM0010 Aerobic Plate Count 004 Sample 4. T=72hrs (NATA Accredited) FM0010 Aerobic Plate Count 'NATA accreditation does not cover the performance of this service. Measurement of Uncertainty values for your compliance are available at https://www.alsglobal.com/au/services-and-products/food-safety/laboratory-downloads/client-downloads Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.



Units

cfu/swab.

cfu/swab.

cfu/swab.

cfu/swab.

22,000

~60,000

~50,000

12,000

Site

NSW

NSW

NSW

NSW

Retail Ready Operation PO Box 97 St Clair NSW, 2759	ns Australia Pty Ltd				
Attention: Sheetal M	laharaj				
Overall Description:	Puradigm 24-hour 2 hourly Reduction Trial on Primal Surface Environmental FlexiSwab. Date start:11/10/2022 (T=0)				
Our Ref No:	FS2259055		Your Ref: 14/10/2022		
Project:			Report Date: 21 Oct 2022		
Samples Received:	17 Oct 2022		Temperature when received: 2.8		
Testing Commenced:	17 Oct 2022				
Samples tested as rece	eived into the laborato	full, without written appro ory, unless the sampling v		Units	Site
Samples tested as rece Sample Details: Test Descr	eived into the laborato iption	ory, unless the sampling	was conducted by ALŚ.	Units	Site
Samples tested as rece	vived into the laborato Piption Ahrs (NATA Accred	ory, unless the sampling	was conducted by ALŚ.	Units cfu/swab.	Site
Samples tested as rece Sample Details: Test Desc 001 Sample 1. T=14	ived into the laborato iption 4hrs (NATA Accredi	bry, unless the sampling v lited) verobic Plate Count	was conducted by ALS. Results		
Samples tested as rece Sample Details: Test Descr 001 Sample 1. T=14 FM0010	elved into the laborato iption 4hrs (NATA Accredi A 4hrs (NATA Accred	bry, unless the sampling v lited) verobic Plate Count	was conducted by ALS. Results		
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Samples tested as reco Sample Details: Test Descr 001 Sample 1. T=14 FM0010 002 Sample 2. T=14 FM0010 003 Sample 3. T=14	ived into the laborato iption 4hrs (NATA Accredi 4hrs (NATA Accredi 4hrs (NATA Accredi 4hrs (NATA Accredi 4hrs (NATA Accredi	ited) ited) verobic Plate Count ited) verobic Plate Count ited) verobic Plate Count	was conducted by ALŚ. Results 8,400 1,700	cfu/swab.	NS

'NATA accreditation does not cover the performance of this service. Measurement of Uncertainty values for your compliance are available at https://www.alsglobal.com/au/services-and-products/food-safety/laboratory-downloads/client-downloads.

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# 6 Milestone 4

Milestone 4 focuses on the implementation through practical trials and initial testing in a production environment, including:

## Install trial units in RROA production HVAC Air Handling Unit (AHU) locations.

Collect and analyse test samples, including:

- Microbiological reductions on surfaces within the HVAC environment
- Mould before and after photos

### **Continue shelf-life trials**

• Microbiological reductions on the surface of fresh primals focusing on speed of reduction for short duration exposures

# 6.1 HVAC AHU – Analysis of Environmental Conditions and Microbiological Reduction Trials

The RR11 red meat Air Handling Unit (AHU) was thoroughly chemically cleaned as part of its usual 3-monthly cleaning cycle.

The previously installed Puradigm HVAC units were powered on to start their cleaning cycle.

Photos of surfaces were taken as the baseline after the chemical clean. These will be compared to surface photos taken at intervals from this baseline until the next chemical cleaning cycle.

The expectation is that the walls exposed to the Puradigm non-thermal plasma output will have a reduction in mould compared to that expected after 3-months.

# Before Chemical Clean – Large quantities of mould on surfaces

The mould build up shown below is typical after 3 months between chemical cleans. It is expected that the Puradigm units will reduce this mould build up and thereby reduce the amount of chemical cleaning either in frequency ie extend to more than 3 months, or in amount of chemicals required to clean all AHU surfaces.





After Chemical Clean – all mould removed










### 6.2 Shelf-Life Room – Microbiological Reduction for Short Exposure Times

In Milestone 3 red meat primals were exposed for long periods of time, up to 24, 96 and 144hrs. This trial was conducted in the QA Retention Chiller Room where samples are stored for analysis. The temperature of the room is 4°C. These red meat *primals had been aged for 35 days*.

In this Milestone 4, the *speed of reduction is calculated for short term durations*. These reductions can then be used to determine how quickly fresh primals can have their surfaces sterilised.



The *fastest rates of reduction* for each test surface 1, 2, 3 and 4 during the Milestone 3 trials were as follows:

Primal Surface 1: 810 counts per second

Primal Surface 2: 503 counts per second

- Primal Surface 3: 353 counts per second
- Primal Surface 4: 68 counts per second

Fresh primals at RROA from previous shelf life studies typically have a plate count of 1000 which means that the surfaces would have the following reduction times to achieve a zero plate count.

Primal Surface 1: 1000 / 810 = 1.23 s Primal Surface 2: 1000 / 503 = 1.99 s Primal Surface 3: 1000 / 353 = 2.83 s

Primal Surface 4: 1000 / 68 = 14.71 s

These reduction times suggest that fresh primals can be decontaminated in very short periods of time with close proximity, between 0.2m to 1.5m, direct exposure to Puradigm NTP. Even with 10x the amount of plate counts, the *exposure times will be no more than 2-3 minutes for complete decontamination.* 

# 6.3 Shelf-Life Room – Microbiological Reduction for combined Denba and Puradigm exposures

Puradigm NTP deactivates or kills viruses and bacteria on surfaces. Denba+ inhibits the growth of bacteria throughout the product for produce which has sufficient quantities of moisture. This trial intends to quantify the extent of the shelf life extension using the combination of these two technologies. Baselines for reductions experienced using Puradigm alone and Denba alone have been conducted in previous milestones within this project, or in the Co-Innovation program's milestones.

Fresh primals will be exposed to 3 minutes of Puradigm NTP on all surfaces and then placed within the Denba freezer at a target temperature of -1.5 to -2C as the test subjects. The Control will be fresh primals which are not exposed to Puradigm NTP or Denba, and placed in a freezer at -1.5C to - 2C.



### Denba and Control Freezers





These trials are ongoing and the results will be reported in a separate project which has been specifically launched to review the benefits of combining the Puradigm and Denba technologies.

### 7 Milestone 5

Practical trials in production environment, including:

- Final results for HVAC trials in Air Handling Units
- Microbiological reduction final report on effectiveness in various conditions and timeframes.
- Packaging decontamination final report on effectiveness

### 7.1 HVAC AHU – Microbiological Reduction Trials in real-world environmental conditions

This final milestone marks the end of the HVAC Air Handling Unit (AHU) two month trial. Usually this point would show mould developing on most of the surfaces in the ductwork across the AHU. However as is evidenced through the following photos, no mould is visible on any of the surfaces, which remain in pristine condition.

A typical non-chemical method of attacking mould is using direct UV light exposure. As can be seen from the chart below, stachybotrys chartarum commonly known as black mould, requires one of the highest exposure times and intensity levels to achieve even the tiny reduction of 0.41%. This chart shows the relative ease with which UV can cause microbial reductions when exposed to different viruses and bacteria. Mould is one of the hardiest pathogens. Given this understanding, Puradigm's results of keeping the black mould from forming on the HVAC AHU surfaces, as is typical every few months, shows that the Puradigm technology is capable of handling bacteria and viruses of all types with a similar, if not even greater efficacy.

Actomonas         0.2031         m2/1         1.13         bacteria         2.038         86.88%           Staphilococcus epidermis         0.1621         m2/1         0.176         m2/1         1.12         bacteria         0.600         82.20%           Staphilococcus epidermis         0.15611         m2/1         1.42         bacteria         0.500         78.40%           Collata humer         0.1531         m2/1         0.1581         m2/1         1.50         bacteria         0.77         78.40%           Collata humer         0.1531         m2/1         1.51         bruius         0.283         78.40%           Vaccinia virus         0.01532         m2/1         0.158         m2/1         1.51         virus         0.283         78.30%           Newcatle disease         0.144000         m2/1         0.118         m2/1         1.018         m2/1         1.018         bucteria         0.386         65.58%           MKSA         0.118         m2/1         0.118         m2/1         1.018         m2/1         0.108         0.232         60.138%           Protewordgaris         0.1057         m2/1         0.0075         m2/1         0.0075         m2/1         0.0075 <t< th=""><th colspan="8">BIO-CONTAMINANT DISTRUCTION RATES WHEN EXPOSED TO UVC - Weakest to Strongest 1 SECOND @</th></t<>	BIO-CONTAMINANT DISTRUCTION RATES WHEN EXPOSED TO UVC - Weakest to Strongest 1 SECOND @								
Cautom unit         Sunit         nu/(nn2)         Type         micron         J.000           Crojobactorim bibrardola         0.4721         m77         0.59         bacteria         0.57         DDINNETCIONE           Crojobactorim Kafsh         0.377         m77         0.59         bacteria         0.57         TSRSP           Consavirus (SARS)         0.378         m77         0.58         bacteria         0.479         TSRSP           Vecolasavirus (SARS)         0.288         m77         0.58         bacteria         0.479         TSRSP           Vecolasavirus (SARS)         0.2931         m77         0.538         m77         0.58         bacteria         0.606         Bacteria         0.606         Bacteria         0.666         Bacteria         0.666         Bacteria         0.666         Bacteria         0.666         Bacteria         0.566         Bacteria         0.566         Bacteria         0.566         Bacteria         0.507         TSAB         Dacteria         0.566         Bacteria         0.567         TAteseria		k in AIR o		r Surf		D 90%		SIZE	UV Dose=microJ/cm2
−         −	Contaminant Name	Custom	unit	Siu	nit	mJ/cm2	Туре	micron	1,000
Legionella pneumophila 0.44613 m2/1 0.424613 m2/1 0.52 bacteria 0.52 98.25% coronavirus (SAS) 0.377 m2/1 0.51 virus 0.513 97.65% virus 0.528 m2/1 0.88 bacteria 0.494 93.44% virus 0.494 94.44% virus 0.496 94.54% virus 0.496									DISINFECTION
Coronavirus (SARS)         0.377         m2/1         0.61         virus         0.113         97.69%           Proteus mirabilisi         0.289         m2/1         0.83         Dacteria         0.149         94.44%           Mycoplana pneumoniae         0.2791         m2/1         0.83         Dacteria         0.177         93.80%           Simmarilis         0.301         m2/1         0.202         M2/1         1.34         Dacteria         0.099         93.80%           Accomonas         0.2031         m2/1         1.13         Dacteria         0.060         82.23%           Staphilococcus epidernis         0.1621         m2/1         1.13         Dacteria         0.860         82.23%           Staphilococcus epidernis         0.1531         m2/1         0.1533         m2/1         1.50         Dacteria         78.43%           Vacchia virus         0.01528         m2/1         1.51         virus         0.307         72.33%           Vacchia virus         0.01528         m2/1         1.51         virus         0.307         72.33%           Vacchia virus         0.01528         m2/1         1.511         virus         0.307         72.33%           Vacchia virus									
Protess mirabilis         0.289         m?/1         0.80         Dacteria         0.434         94.44%           Mycoplass parenemoniae         0.2791         0.233         m?/1         0.80         Dacteria         0.717         93.86%           Lideria monocytogenes         0.233         m?/1         0.233         m?/1         0.030         Dacteria         0.707         93.86%           Signonella monocytogenes         0.237         m?/1         0.161         m?/1         0.1621         m?/1         0.1621         m?/1         0.171         1.33         Dacteria         0.606         82.28%           Signonella provacebil         0.1521         m?/1         0.1621         m?/1         0.1621         m?/1         1.48         Dacteria         0.566         80.23%           Cadelaburnell         0.1535         m?/1         0.153         m?/1         1.51         merce         76.33%           Smallon         0.001528         m?/1         1.51         mris         0.212         76.33%           Actenetoater baumani         0.118         m?/1         0.118         m?/1         1.51         mris         0.212         76.33%           Macian blumazavina         0.1140         m?/1         <	Legionella pneumophila	0.44613	m2/J						
Mycoplasna pneumoniae         0.2791         m7/1         0.83         bacteria         0.177         93.86%           Sidmonela         0.221         m7/1         0.04         bacteria         0.800         93.35%           Sidmonela         0.221         m7/1         0.147         m7/1         1.04         bacteria         0.800         89.35%           Sigmonax waretii         0.1561         m7/1         0.1571         m7/1         1.42         bacteria         0.866         80.23%           Sigmona pneuwaretii         0.1561         m7/1         0.1531         m7/1         1.50         bacteria         0.707         78.46%           Codelal burnetii         0.13531         m7/1         0.1533         m7/1         1.50         bacteria         0.77         78.45%           Catobacter buanti         0.13531         m7/1         0.133         m7/1         1.50         bacteria         0.78         78.45%           Catobacter buanti         0.128         m7/1         0.138         m7/1         1.50         bacteria         0.28         78.45%           Catobacter buanti         0.128         m7/1         0.137         1.14         m7/1         1.14         1.160         1.177									
Listeria nonocytogenes									
Salmonella         0.221         m2/1         0.221         m2/1         1.04         bacteria         0.803%           Recornona         0.2031         m2/1         0.131         bacteria         0.208         86.38%           Rickectia prowazell         0.176         m2/1         0.1351         m2/1         1.131         bacteria         0.208         86.38%           Rickectia prowazell         0.1551         m2/1         0.1553         m2/1         1.50         bacteria         0.77         78.45%           Cocilea burnetti         0.1535         m2/1         0.1535         m2/1         1.50         bacteria         0.283         78.45%           Varcina virus         0.153         m2/1         0.153         m2/1         1.51         bacteria         0.283         78.45%           Varcina virus         0.138         m2/1         0.138         m2/1         1.51         bacteria         0.212         77.435%           Annetobacter barmait         0.128         m2/1         1.54         britus         0.307         78.35%           Mixa         0.131         m2/1         0.111         m2/1         2.01         M1/2         M1/2         M1/2         M1/2         M1/2	Listeria monocytogenes	0.2303	m2/J						
Bitosecta prowazekii         0.176         m2/1         1.31         bacteria         0.586         82.80%           Staphilococcus peldermis         0.15511         m2/1         1.48         bacteria         0.566         80.23%           Conclass humetii         0.1531         m2/1         1.535         m2/1         1.535         m2/1         1.535           Vaccinia virus         0.1531         m2/1         1.535         m2/1         1.535         m2/1         1.535           Syscinia virus         0.1531         m2/1         1.535         m2/1         1.517         0.337         78.33%           Syscinia virus         0.128         m2/1         0.138         m2/1         1.51         0.307         78.33%           Mileana         0.131         m2/1         0.128         m2/1         1.50         virus         0.338         69.25%           Mileana         0.131         m2/1         0.138         m2/1         1.40         Virus         0.398         69.53%           Peudomona acruginosa         0.1051         m2/1         0.108         m2/1         2.00         virus         0.398         65.33%           Peudomona acruginosa         0.1051         m2/1         0.0	Salmonella	0.221	m2/J	0.221	m2/J	1.04	bacteria	0.800	
Staphilococcus epidermis         0.1621         m2/1         1.42         bacteria         0.88         80.23%           Verishia enterocolitica         0.15511         m2/1         0.1581         m2/1         1.50         bacteria         0.500         78.46%           Codella burnetti         0.1335         m2/1         1.50         bacteria         0.283         78.45%           Catobaclilus reuteri         0.1335         m2/1         1.50         bacteria         0.283         78.45%           Catobaclilus reuteri         0.1335         m2/1         1.50         bacteria         0.283         78.45%           Catobacteri bamanii         0.0125         m2/1         0.138         m2/1         1.018         m2/1         1.018         m2/1         0.138         m2/1         1.018         m2/1         0.138         m2/1         0.118         m2/1         0.118         m2/1         0.118         m2/1         1.018         m2/1         1.018         m2/1         0.128         m2/2         0.038         65.35%           MKSA         0.131         m2/1         0.111         m2/1         1.018         m2/1         1.018         m2/1         1.016         1.018         1.018         1.018         1	Aeromonas							2.098	86.88%
E. Coli         0.15611         m2/1         0.1581         m2/1         1.88         bacteria         0.570         78.40%           Codella burnetii         0.1533         m2/1         0.1533         m2/1         1.50         bacteria         0.270         78.40%           Codella burnetii         0.1333         m2/1         0.153         m2/1         1.50         bacteria         0.270         78.40%           Codella burnetii         0.1332         m2/1         1.51         bacteria         0.271         7.143         0.153         77.153         0.071         78.30%           Newcastle disease         0.001328         m2/1         0.118         m2/1         0.118         1.11         virus         0.027         67.10%           Cosachtevirus         0.113         m2/1         0.118         m2/1         1.14         virus         0.038         65.35%           Feudomona senginosa         0.1061         m2/1         0.114         m2/1         1.017         0.1047         1.014         1.014         1.014         1.014         1.014         1.014         1.014         1.014         1.014         1.014         1.014         1.014         1.014         1.014         1.014         1.014	Ricksettsia prowaze kii	0.176	m2/J	0.176	m2/J	1.31		0.600	
Versinal enterocolitica         0.15351         m2/1         0.1535         m2/1         1.50         bacteria         0.78         78.45%           Cactobacillus reuteri         0.1535         m2/1         0.1535         m2/1         1.50         bacteria         0.283         78.45%           Svacinia virus         0.0153         m2/1         0.153         m2/1         1.51         virus         0.307         78.35%           Smallpox         0.00153         m2/1         0.118         m2/1         1.51         virus         0.307         78.35%           Aminobact rese         0.00133         m2/1         0.118         m2/1         1.180         virus         0.307         78.35%           Mixa         0.118         m2/1         0.118         m2/1         1.180         virus         0.386         67.35%           Mixa         0.111         m2/1         0.111         m2/1         2.17         virus         0.028         65.35%           Meade virus         0.1031         m2/1         0.1031         m2/1         2.17         virus         0.329         65.04%           Feredomonas arruginosa         0.1037         m2/1         0.307         m2/1         3.00									
Coxiel la burnetii         0.1535         m2//         0.1535         m2//         0.1535         m2//         0.1535         m2//         0.153         m2//         0.154         m2//         0.156         m2//         0.156         m2//         0.166         m2//         0.166         m2//         0.166         m2//         0.171         m2//         0.166         m2//         0.217         virus         0.032         65.03%           Meaale virus         0.1061         m2//         0.1061         m2//         0.217         virus         0.032         65.03%         65.03%         65.03%         65.03%         65.03%         65.03%         65.03%         65.03%         65.03%         65.03%         65.03%         65.03%         65.03%         65.03%         65.03%         65.03%									
Lactobacillus reuteri         0.1535         m2/1         0.153         m2/1         0.151         virus         0.307         78.35%           Actinetobacter haumani         0.118         m2/1         0.124         m2/1         1.160         virus         0.021         78.33%           Missioniterius         0.0118         m2/1         0.124         m2/1         0.134         m2/1         0.134         m2/1         0.134         m2/1         0.035         65.33%           Missioniterius         0.1051         m2/1         0.1061         m2/1         0.1061         m2/1         0.1061         m2/1         0.1061         m2/1         0.1064         m2/1         0.0161         m2/1         0.0161         m2/1         0.025         m2/1         0.220         bacteria         0.632         61.33%           Perudomonas areuginosa         0.0055         m2/1         0.0265         m2/1         0.021         m2/1         0.021         m2/1         0.021         m2/1         0.021         m2/1<									
smallpox         0.001528 (m2/µ)         0.1528 (m2/µ)         0.151 (m2/µ)         78.30%           Actinetobacter baumanii         0.128 (m2/µ)         0.128 (m2/µ)         1.18 (m2/µ)         0.128 (m2/µ)         0.212 (m3/µ)           Actinetobacter baumanii         0.113 (m2/µ)         0.128 (m2/µ)         1.13 (m2/µ)         0.138 (m2/µ)         0.013 (m2/µ)         0.014 (m2/µ)         0.015 (m2/µ)         0.014 (m2/µ)         0.015 (m2/µ)         0.015 (m2/µ)         0.014 (m2/µ)	Lactobacillus reuteri				m2/J				
Newcastle disease         0.144000         m2// mifuenza virus         0.12         76.31% m2// mifuenza virus         0.119         m2// m2// m2// m3/         0.128         m2// m2// m2// m3/         0.128         m2// m2// m2// m3/         0.138         m2// m2// m3/         0.138         m2// m2// m2/         0.138         m2// m2/         0.138         m2// m2/         0.131         m2// m2/         0.131         m2// m2/         0.131         m2// m2/         0.131         m2// m2/         0.134         m2// m2/         0.134         m2// m2/         0.134         m2// m2/         0.135         m2// m2/         0.147         m2// m2/         0.135         m2// m2/         0.135         m2// m2/         0.135         m2// m2/         0.135         m2// m2/         0.135         m2// m2/         0.135         m2// m2/         0.147         0.1047         m2// m2/         0.250         m2// m2/         0.250         m2// m2/         0.250         m2// m2/         0.250         m2// m2/         0.261         m2// m2/         0.261         m2// m2/         0.261         m2// m2//         0.261         m2// m2	Vaccinia virus	0.153	m2/J				virus	0.307	
Acinetobacter baumani         0.128         m2/J         0.128         m2/J         1.80         bacteria         1.225         72.20%           MRSA         0.113         m2/J         0.113         m2/J         0.134         m2/J         0.135         m2/J         0.135         m2/J         0.134         m2/J         0.134         m2/J         0.204         bacteria         0.866         67.70%           Gosachievirus         0.111         m2/J         0.106         m2/J         0.101         m2/J         0.17         virus         0.038         65.35%           Meade virus         0.1051         m2/J         0.1031         m2/J         2.17         virus         0.328         65.04%           Pervorius Hirit         0.0397         m2/J         0.0392         m2/J         2.275         virus         0.032         61.33%           Pervorius Hirit         0.007675         m2/J         0.0392         m2/J         3.250         virus         0.035         53.53%           Streptococcus pyogenes         0.06558         m2/J         0.0559         m2/J         3.50         fungis p         5.916         44.50%           Keptocus pyogenes         0.06559         m2/J         0.358	smallpox								
Influenza Virus         0.119         m2/1         0.139         m2/1         0.139         m2/1         0.139         m2/1         0.131         m2/1         0.131         m2/1         0.013         m2/1         0.013         m2/1         0.013         m2/1         0.013         m2/1         0.000         wirus         0.038         65.35%           Meade virus         0.1051         m2/1         0.106         m2/1         2.17         virus         0.039         65.35%           Meade virus         0.1051         m2/1         0.0131         m2/1         2.17         virus         0.039         65.35%           Serretinnonce regions         0.1097         m2/1         0.0175         m2/1         0.0767         m2/1         0.0767         m2/1         0.0767         m2/1         0.0767         m2/1         0.0768         m2/1         0.0767         m2/1         0.0768         m2/1         0.0761         m2/1         0.0775         m2/1         0.0775         m2/1         0.0775         m2/1         0.0775         m2/1         0.0775         m2/1         0.0789         m2/1         0.0789         m2/1         0.0789         m2/1         0.0789         m2/1         0.078         m2/1         0.071 </th <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>76.31%</th>									76.31%
MRSA         0.113         m2//         0.113         m2//         0.204         Dacteria         0.566         67.70%           Avan Influenza virus         0.116         m2//         0.106         m2//         0.107         virus         0.027         67.04%           Meade virus         0.106         m2//         0.106         m2//         0.113         m2///         1.113         m2///         1.113         m2///         1.113         m2///         1.113         m2///         1.113         1.113         1.113         1.113         1.113         1.113									
Consachievirus         0.111         m2/1         0.01         m2/1         0.07         virus         0.027         67.04%           Meade virus         0.1051         m2/1         0.1051         m2/1         0.105         m2/1         0.105           Meade virus         0.01051         m2/1         0.1047         m2/1         0.1047         m2/1         0.1047         m2/1         0.1047         m2/1         0.1047         m2/1         0.1047         m2/1         0.005         m2/1         0.0047         m2/1         0.0047         m2/1         0.002         Boateria         0.032         Boateria         0.032         Boateria         0.032         Boateria         0.032         Boateria         0.032         Boateria         0.032         Boateria         0.035         Boateria         0.037         Boateria         0.037         Boateria         0.037         Boateria         0.037									
Avian Influenza virus         0.106         m2/l         0.217         virus         0.038         65.35%           Meade virus         0.0107         m2/l         0.217         virus         0.328         65.04%           Secudomonas aeruginosa         0.01047         m2/l         0.218         bacteria         0.0328         65.04%           Serratia marcescens         0.0352         m2/l         0.238         m2/l         2.42         bacteria         0.632         65.13%           Oriena vigaris/mobilis         0.0392         m2/l         0.238         batteria         0.632         65.13%           Oriena vigaris/mobilis         0.0391         m2/l         0.359         m2/l         0.359         m2/l         0.359         m2/l         0.358         datassis           Virus         0.0559         m2/l         0.0559         m2/l         0.355         m2/l         0.358         datassis         datassis           Vesat         0.0559         m2/l         0.0559         m2/l         0.358         m2/l         0.358 <t< th=""><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></t<>									
Meade virus         0.1051         m2/1         0.105         m2/1         0.105         m2/1         0.107         m2/1         0.1047         m2/1         0.220         bacteria         0.632         63.33%           Parvovirus H1         0.095         m2/1         0.092         m2/1         0.221         bacteria         0.0221         60.15%           Orynebacterium diphteriae         0.07675         m2/1         0.071         m2/1         3.250         virus         0.0221         53.38%           Osillago zeae         0.0658         m2/1         0.0583         m2/1         3.54         40.15%         40.15%           Vestoria catarrhalis/meingitidis         0.05756         m2/1         0.0583         m2/1         4.40         bacteria         0.071         42.19%           Vestoria catarrhalis/meingitidis         0.035233         m2/1         0.0459         m2/1         4.40         bacteria         0.177         40.74%           Costridium fean         0.0459         m2/1         0.5356         m2/1         5.50         virus									65.35%
Serratia marcescens         0.095         m2/1         0.242         Decteria         0.632         G.133%           Parovirus H1         0.092         m2/1         0.242         m2/1         0.632         G.15%           Protexs vulgaris/mirabilis         0.07675         m2/1         0.07675         m2/1         0.071         m2/1         0.711         m2/1         0.721         0.711         m2/1         0.721         0.711         m2/1         0.724         0.721         0.724         0.721         0.7263         m2/1         0.721         0.7265         m2/1         0.721         0.7265         m2/1         0.721         0.7265         m2/1         0.721         0.7266         m2/1         0.721         0.7266         m2/1         0.721         0.721         0.721         0.721         0.721         0.721	Measle virus	0.1051	m2/J		m2/J	2.19			65.04%
Parvotivus H-1         0.092         m2/1         2.50         virus         0.022         60.15%           Portous vugarizymirabilis         0.0701         m2/1         0.300         bacteria         0.291         53.58%           Corynebacterium diphteriae         0.0701         m2/1         0.305         m2/1         0.307         S.21         wirus         0.007         S.22%         M2/2%         M2/2%         M2/2%         M2/2%         M2/2%         M2/2% </th <th>Pseudomonas aeruginosa</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>	Pseudomonas aeruginosa								
Proteus vulgaris/mirabilis         0.07675         m2/1         0.076         m2/1         0.0658         m2/1         0.0669         m2/1         0.0669         m2/1         0.0669         m2/1         0.0669         m2/1         0.077         3.78%         0.077         3.74%         0.077         3.74%         0.078         3.74%         0.076         3.74%         0.077         3.26%         0.078         3.74%         0.077         3.26%         0.078         3.74%         0.077         3.74%         0.077         3.26%         0.078         3.74%         0.077         3.26%         0.077	Serratia marcescens								
Coryne Bockterium diphteriae         0.0701         m2/l         0.071         m2/l         3.29         bacteria         0.588         S0.39%           Streptococcus pyogenes         0.0658         m2/l         0.658         m2/l         0.530         funging         5.916         482.1%           Streptococcus pyogenes         0.06161         m2/l         0.359         m2/l         3.34         bacteria         0.285         45.06%           Weat         0.05759         m2/l         0.3578         m2/l         4.40         bacteria         0.285         45.06%           Nisseria catarinality meingitidii         0.05759         m2/l         4.34         bacteria         0.717         40.74%           Clostridum tetani         0.04699         m2/l         0.0499         m2/l         5.50         virus         0.055         34.23%           Surkholderia cenocepacia         0.03356         m2/l         0.538         m2/l         0.548	Parvovirus H-1	0.092	m2/J	0.092	m2/J				
Ustilagore zae         0.06558         m2/1         0.0658         m2/1         0.06518         m2/1         0.06518         m2/1         0.06518         m2/1         0.06518         m2/1         0.065161         m2/1         0.06161         m2/1         0.06161         m2/1         0.06161         m2/1         0.06161         m2/1         0.06161         m2/1         0.05759         m2/1         0.05756         m2/1         0.05756         m2/1         0.05756         m2/1         0.05756         m2/1         0.05756         m2/1         0.05756         m2/1         0.03756         m2/1         0.0338         m2/1         0.0338         m2/1         0.0338         m2/1         0.0338         m2/1         0.0358         m2/1         0.03595         m2/1         0.03595         m2/1         0.03595         m2/1         0.03595         m2/1         0.03595         m2/1         0.0358         m2/1									
Streptococcus pyogenes         0.06161         m2/1         0.059         m2/1         0.374         bacteria         0.894         4500%           Veast         0.05756         m2/1         0.3755         m2/1         0.438         bacteria         0.285         45.06%           Veast         0.05756         m2/1         0.05756         m2/1         0.434         m2/1         0.548         m2/1         0.548         m2/1         0.548         m2/1         0.548         m2/1         0.4348         m2/1         0.4369         m2/1         0.3495         m2/1         0.351         m2/1         0.351         m2/1         0.335         m2/1         0.336         m2/1         0.336         m2/1         0.336         m2/1         0.336         m2/1         0.336 <td< th=""><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></td<>									
Haemophius influenza         0.05599         m2/1         0.3559         m2/1         0.3559         m2/1         0.3559         m2/1         0.3555         m2/1         0.3555         m2/1         0.3555         m2/1         0.3555         m2/1         0.3555         m2/1         0.400         VegV         0.000         43.76%           Klebsiela pneumoniae         0.0419         m2/1         0.0533         m2/1         4.30         bacteria         0.171         42.13%           Klebsiela pneumoniae         0.04699         m2/1         0.34358         m2/1         4.30         bacteria         0.177         40.74%           Clockridium tetani         0.03695         m2/1         0.0395         m2/1         5.32         virus         0.0797         32.25%           Adenovirus         0.03358         m2/1         0.0395         m2/1         5.38         m2/1         0.335           Revirus         0.03358         m2/1         0.0395         m2/1         5.38         virus         0.075         28.52%           Revirus         0.03158         m2/1         0.0316         m2/1         1.378         tirus         0.024         18.078           Resirus adarinschas         0.01419 <td< th=""><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></td<>									
Klebsiella pneumoniae         0.0419         m2/1         0.0548         m2/1         4.20         bacteria         0.671         42.19%           Clostridium tetani         0.06499         m2/1         0.438         m2/1         4.40         bacteria         0.177         40.74%           Clostridium tetani         0.064699         m2/1         0.04699         m2/1         5.50         virus         0.005         34.23%           Burkholderia cenocepacia         0.03956         m2/1         0.03358         m2/1         5.52         bacteria         0.077         32.67%           Adenovirus         0.03355         m2/1         0.0338         m2/1         5.52         bacteria         0.017         32.67%           Michanista         0.03355         m2/1         0.0338         m2/1         6.34         wirus         0.027         28.22%           Norvalk virus         0.0355         m2/1         0.0334         m2/1         1.538         wirus         0.027         28.22%           Recillus Anthais         0.0167         m2/1         1.0164         m2/1         1.017         1.178         Virus         0.022         26.21%           Bacillus Anthais         0.01619         m2/1	Haemophilus influenza	0.0599	m2/J	0.0599				0.285	45.06%
Neisseria catarthalis/meningitidis         0.05233         m2/1         0.40233         m2/1         0.449           Clostridium tetani         0.06459         m2/1         0.4695         m2/1         0.4695           VRE         0.0419         m2/1         0.4619         m2/1         0.5655         m2/1         0.5655           VRE         0.0419         m2/1         0.04358         m2/1         0.5356         m2/1         0.5356           Adenovirus         0.03358         m2/1         0.03388         m2/1         0.5356         m2/1         0.5356           Ricrobacter cloacae         0.03358         m2/1         0.03388         m2/1         0.5358         m2/1         0.5358           Ricrobacter cloacae         0.03358         m2/1         0.0338         m2/1         0.525         virus         0.0243         30.225           Ricrobacter cloacae         0.0167         m2/1         0.0167         m2/1         18.79         turius         0.023         32.27%           Bactinus subitis spores         0.0167         m2/1         0.0165         m2/1         14.00         Vegttria         1.538%           Bactores proces         0.01645         m2/1         14.00         Vegttria	Yeast						VegY		
Clostratium tetani         0.04699         m2/1         0.04699         m2/1         6.490         mail         Solo         37.43%           Wite         0.0419         m2/1         0.04199         m2/1         5.50         virus         0.065         34.23%           Burkholderia cenocepacia         0.03356         m2/1         0.538         m2/1         5.50         virus         0.065         34.23%           Gaterobacter closace         0.03358         m2/1         0.638         m2/1         6.33         virus         0.079         32.25%           Choronal struct         0.03358         m2/1         0.630         m2/1         0.531         virus         0.079         32.25%           Chorona         0.03358         m2/1         0.0347         m2/1         0.538         0.027         virus         0.023         26.21%           Chorona         0.0167         m2/1         0.0167         m2/1         1.037         virus         0.024         13.53%           Bistomyces dermatidis         0.0419         m2/1         0.01645         m2/1         1.014.00         fungi p.         1.030         13.13%           Bistomyces dermatidis         0.0419 m2/1         0.01645 m2/1								0.671	42.19%
VRE         0.0419         m2/1         0.536         34.23%           Surkholderizencepacia         0.03356         m2/1         0.5356         m2/1         0.5356         m2/1         0.5356         m2/1         0.5356         m2/1         0.5356         m2/1         0.535         m2/1         0.535         m2/1         0.535         m2/1         0.5358         m2/1         0.638         m2/1         0.634         m2/1         0.634         m2/1         0.634         m2/1         0.758         virus         0.012         2.521%           Revorus         0.03358         m2/1         0.0167         m2/1         1.788         virus         0.012         2.521%           Revorus         0.0167         m2/1         0.0167         m2/1         1.789         barreria         1.138         3.538%           Baisomyces dermatidis         0.0419         m2/1         0.01645         m2/1         1.0164         m2/1         1.0164         m2/1         1.0179         1.1379         Lungi p	Neisseria catarrhalis/meningitidis	0.05233	m2/J					0.177	
Burkholderia cenocepacia         0.033956         m2/1         0.033956         m2/1         5.82         bacteria         0.707         32.67%           Adenovirus         0.033958         m2/1         0.03588         m2/1         0.635         m2/1         0.637           Enterobacter cloacae         0.03358         m2/1         0.63588         m2/1         0.63588         m2/1         0.03588         m2/1         0.63588         m2/1         0.63588         m2/1         0.63588         m2/1         0.63588         m2/1         0.63588         m2/1         0.63588         m2/1         0.5358         m2/1         0.5450         m1/2         0.0167         m2/1         1.52         virus         0.024         136.75%         55.5		0.04699	m2/J						
Adenovirus         0.039         m2/1         0.039         m2/1         5.51         virus         0.079         32.29%           Riterobacter Cloace         0.03358         m2/1         0.6358         m2/1         0.640         bacterial         1.414         30.22%           Reovirus         0.03358         m2/1         0.6358         m2/1         0.6364         m2/1         0.6364         m2/1         0.6364         m2/1         0.6364         m2/1         0.6364         m2/1         0.758         virus         0.029         25.21%           Revirus         0.0167         m2/1         0.0167         m2/1         1.78         virus         0.029         25.21%           Rellus Arthacis         0.0167         m2/1         0.1645         m2/1         1.79         bacteria         1.118         1.53.8%           Cyptocccus neolommans         0.01645         m2/1         0.01645         m2/1         1.400         Vegturg         2.550         1.51.7%           Mucor spores         0.01645         m2/1         0.01445         m2/1         1.400         Vegturg         1.51.7%         1.436%           Francisella Tularensis         0.01647         m2/1         0.0142         m2/1 <t< th=""><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></t<>									
Enterobacter cloacae         0.033598         m2/1         0.033598         m2/1         0.03358         m2/1         0.03158         m2/1         0.0317         225.27%           Rorwalk virus         0.0167         m2/1         0.0167         m2/1         1.0152         virus         0.024         135.67%           Bacillus Anthacis         0.0167         m2/1         0.0167         m2/1         1.379         bacteria         1.118         15.38%           Cryptoocccurs neoformans         0.0419         m2/1         0.01645         m2/1         1.400         Vegturg         1.1000         15.17%           Macorspores         0.01645         m2/1         0.01645         m2/1         1.400         Vegturg         1.1200         13.17%           Wacillus subtilis pores         0.01645         m2/1         0.01645         m2/1         1.61.22         fungi p         1.120         14.36%           Vearius anturo sopores <td< th=""><th>Adenovirus</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></td<>	Adenovirus								
Recovirus         0.03358         m2/1         0.03358         m2/1         6.86         virus         0.075         28.52%           Okorvalk virus         0.03458         m2/1         0.584         m2/1         0.584         m2/1         0.584         m2/1         0.584         m2/1         0.584         m2/1         0.021         m2/1         0.558         virus         0.027         28.21%           Becillus Anthacis         0.01617         m2/1         0.0157         m2/1         1.58         virus         0.028         28.21%           Becillus Anthacis         0.01617         m2/1         0.1617         m2/1         1.378         fungi p.         4.893         1.338%           Becillus Anthacis         0.01645         m2/1         0.01645         m2/1         0.01645         m2/1         0.01645         m2/1         0.01645         m2/1         0.01645         m2/1         0.01646         ma/1         1.600         Vergi p.         1.120         1.137%         Bacteria         1.120         1.1438%           Francisella fularensis         0.01647         m2/1         0.0147         m2/1         1.622         fungi p.         1.1225         1.1325         1.32%           Francisella fularensis<	Enterobacter cloacae			0.03598			bacteria	1.414	30.22%
Echovirus         0.217         m2/1         0.0219         m2/1         10.52         virus         0.024         19.67%           Bacillus Anthacis         0.0167         m2/1         0.0167         m2/1         10.79         bacillus Anthacis         0.0167 m2/1         0.177         main anthacis         1.118         11.38         11.38         11.38         11.38         11.38         11.38         11.38         11.38         11.38         11.38         11.378         fungi sp         4.899         13.38%         13.378         fungi sp         4.899         13.38%         13.378         fungi sp         4.899         13.38%         13.176         <	Reovirus								
Bacillus Anthacis         0.0167         m2/1         0.0167         m2/1         13.79         bacteria         1.118         15.38%           Blastomyces dermatidis         0.0419         m2/1         0.01645         m2/1         13.79         bacteria         1.118         15.38%           Blastomyces dermatidis         0.0419         m2/1         0.01645         m2/1         14.00         Vegtv         11.000         15.17%           Hitoplasma cagsulatum         0.04164         m2/1         0.01645         m2/1         14.00         Vegtv         11.000         15.17%           Mucor spores         0.01645         m2/1         0.01645         m2/1         14.00         Vegtvi         11.000         15.17%           Bacillus sublisspores         0.01645         m2/1         0.0142         m2/1         16.162         fungi p         1.125         11.325         11.325           Francisella tularensis         0.01617         m2/1         0.0142         m2/1         1.1225         11.325         11.325           Bottypiscinerea         0.0032         m2/1         0.0132         m2/1         1.772         bacteria         1.125         11.255           Bottypis singricans         0.00661         m2/1 </th <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>									
Cryptococcus neoformans         0.0419         m2//         0.0167         m2//         11.8.79         fungisp         4.89         15.38%           Bistomyces dermatidis         0.0419         m2//         0.01645         m2//         1.1.00         Vigrit         1.000         15.17%           Histopisma capsulatum         0.0419         m2//         0.01645         m2//         1.1.00         Vigrit         2.550         15.1.7%           Muccor spores         0.01655         m2//         0.01645         m2//         1.1.00         fungi         7.070         15.1.7%           Bacillus subtilis spores         0.0142         m2//         0.0147         m2//         1.1.62         fungi pp         1.1.23         13.24%           Powdery Mildew         0.013         m2//         0.1.77         b.3.21%         1.1.80         7.795           Nicopus nigricans         0.0062         m2//         1.0.22         fungi pp         1.1.23         3.2.4%           Nodery Mildew         0.0132         m2//         0.1.772         b.3.21%         1.1.80         7.795           Nicopus nigricans         0.00621         m2//         0.00821         m2//         2.0.86         fungi pp         3.2.66         6.0.87									
Biaktomyces dermatidis 0.0419 m2// 0.01645 m2// 14.00 Vegt 1.000 15.17% Histoplasma capsulatum 0.0419 m2// 0.01645 m2// 14.00 Vegt (m2) 2.550 15.17% Bucor spores 0.01645 m2// 0.01645 m2// 14.00 Vegt (m2) 2.550 15.17% Bacillus sublis spores 0.0155 m2// 0.14.66 bacteria 1.120 14.36% Francisella tularensis 0.144000 m2// 0.0147 m2// 15.62 virus 0.200 13.71% Francisella tularensis 0.144000 m2// 0.0147 m2// 15.62 virus 0.200 13.71% Evasitium sysporum 0.0142 m2// 0.0132 m2// 15.62 virus 0.200 13.71% Foxed particle 1.120 11.255 m2// 14.66 bacteria 1.120 11.255 13.24% Powdery Mildew 0.013 m2// 0.013 m2// 17.72 bacteria 0.707 12.19% Botrytiscinerea 0.0032 m2// 0.0022 m2// 15.23 fungi pp 11.138 7.89% Rhizopus nigricans 0.00651 m2// 0.00861 m2// 26.75 fungi pp 6.528 8.25% Nocardia asteroides 0.008521 m2// 0.00718 m2// 15.62 fungi pp 1.1.18 7.89% Penicillium digitatum 0.00718 m2// 0.00718 m2// 32.08 fungi pp 1.1.18 5.48% Algae blue-green 0.00512 m2// 0.0084 m2// 44.98 algae 5.000 4.99% Penicillium dirygenum 0.00441 m2// 0.0043 m2// 55.36 fungi pp 3.262 4.25% Trichophyton rubrum 0.00441 m2// 0.0047 m2// 55.58 Vegt 4.899 4.03% Camdida abicans 0.00407 m2// 0.0007 m2// 55.58 Vegt 4.899 3.99% Scopulariopis brevicaulis 0.00384 m2// 0.00385 m2// 47.9 bacteria 0.118 3.05% Scopulariopis brevicaulis 0.00344 m2// 0.00385 m2// 47.9 bacteria 0.118 3.05% Scopulariopis brevicaulis 0.00344 m2// 0.00385 m2// 47.9 bacteria 0.0560 3.77% Caddga abicans 0.00407 m2// 0.00384 m2// 55.88 Vegt 4.899 3.99% Scopulariopis brevicaulis 0.00344 m2// 0.00385 m2// 47.9 bacteria 0.0560 3.77% Caddgaporium herbarum 0.00318 m2// 0.00386 m2// 40.224 fungi pp 8.062 3.63% Scopulariopis brevicaulis 0.00344 m2// 0.00385 m2// 47.9 bacteria 1.118 3.05% Caddgoporium herbarum 0.00318 m2// 0.00385 m2// 451.57 fungi pp 8.062 3.63% Scopulariopis brevicaulis 0.00344 m2// 0.00385 m2// 451.57 fungi pp 8.062 3.63% Scopulariopis brevicaulis 0.00318 m2// 0.00385 m2// 451.57 fungi pp 8.062 3.63% Scopulariopis brevicaulis 0.00318 m2// 0.0038 m2// 451.57 fungi pp 8.062 0.51%	Bacillus Anthacis	0.0167	m2/J	0.0167	m2/J	13.79	bacteria fungi co		15.38%
Histopisma capsulatum         0.0419         m2//         0.01645         m2//         11.00         Vegfungi         2.55         15.17%           Muccor spores         0.0.1655         m2//         0.1645         m2//         11.400         fungi         7.070         15.17%           Bacillus subtilis spores         0.0.155         m2//         0.1645         m2//         11.400         fungi         7.070         15.17%           Bacillus subtilis spores         0.0.142         m2//         0.0147         m2//         17.17         bacteria         1.120         14.366%           Franciselia Tularensis         0.0.142         m2//         10.13         m2//         10.77         bacteria         0.120         13.17%           Powdery Mildew         0.013         m2//         10.77         bacteria         0.170         12.13%           Bottytiscinerea         0.00621         m2//         0.0146         m2//         2.038         fungi sp         3.262         6.385           Rocardia setroides         0.00654         m2//         0.0141         m2//         2.028         fungi sp         3.262         6.385           Rocardia setroides         0.00654         m2//         0.0211         m2//	Blastomyces dermatidis						VegY		
Bacillus subtilis spores         0.0155         m2/l         0.0155         m2/l         14.86         bacteria         1.120         14.86%           Francisella Tularensis         0.01400 m2/l         0.0147         m2/l         15.62         virus         0.200         13.71%           Francisella Tularensis         0.0142 m2/l         0.0142 m2/l         16.22         fungi sp         11.225         13.24%           Powdery Mildew         0.013 m2/l         0.013 m2/l         7.72         bacteria         0.707         11.80         8.79%           Biotpois Ginerea         0.0082 m2/l         0.00821 m2/l         25.03         fungi sp         6.928         8.25%           Nocardia sateroides         0.00821 m2/l         0.00821 m2/l         2.08         fungi sp         3.262         6.938           Bacillus Carcus spores         0.00564 m2/l         0.00812 m2/l         4.828         fungi sp         3.262         4.83%           Algae blue green         0.00513 m2/l         0.00431 m2/l         5.63         fungi sp         3.262         4.25%           Paricillum Chrysogenum         0.00434 m2/l         0.00431 m2/l         5.63         fungi sp         3.262         4.25%           Candida abicans         0.00407 m2/l	Histoplasma capsulatum								
Bacillus subtilis spores         0.0155         m2/l         0.0155         m2/l         14.86         bacteria         1.120         14.86%           Francisella Tularensis         0.01400 m2/l         0.0147         m2/l         15.62         virus         0.200         13.71%           Francisella Tularensis         0.0142 m2/l         0.0142 m2/l         16.22         fungi sp         11.225         13.24%           Powdery Mildew         0.013 m2/l         0.013 m2/l         7.72         bacteria         0.707         11.80         8.79%           Biotpois Ginerea         0.0082 m2/l         0.00821 m2/l         25.03         fungi sp         6.928         8.25%           Nocardia sateroides         0.00821 m2/l         0.00821 m2/l         2.08         fungi sp         3.262         6.938           Bacillus Carcus spores         0.00564 m2/l         0.00812 m2/l         4.828         fungi sp         3.262         4.83%           Algae blue green         0.00513 m2/l         0.00431 m2/l         5.63         fungi sp         3.262         4.25%           Paricillum Chrysogenum         0.00434 m2/l         0.00431 m2/l         5.63         fungi sp         3.262         4.25%           Candida abicans         0.00407 m2/l	Mucor spores	0.01645	m2/J	0.01645	m2/J	14.00	fungi	7.070	15.17%
Fusarium oxpoprum         0.0142         m2/1         0.0142         m2/1         0.16.22         fungi sp         11.215         13.24%           Powdery Mildew         0.013         m2/1         0.013         m2/1         0.777         Lasts         13.24%           Bortyfiscinerea         0.0092         m2/1         0.0092         m2/1         7.72         bacteria         0.707         11.180         8.79%           Biotopus nigricans         0.00861         m2/1         0.26861         m2/1         25.675         fungi sp         6.328         8.25%           Poncillium digitasten         0.00852         m2/1         0.00811         m2/1         25.08         fungi sp         3.262         6.33%           Bacillus Cercus spores         0.00512         m2/1         0.00544         m2/1         40.83         fungi sp         3.262         4.25%           Paricillum chrosogenum         0.00512         m2/1         0.00544         m2/1         56.08         fungi sp         3.262         4.25%           Candida abicans         0.004071         m2/1         56.58         Vegt         4.899         3.99%           Candida abicans         0.004071         m2/1         56.58         Vegt	Bacillus subtilis spores	0.0155	m2/J	0.0155	m2/J	14.86	bacteria	1.120	14.36%
Powdery Mildew         0.013         m2/1         0.013         m2/1         0.772         L19%           Botrytiscinerea         0.0032         m2/1         0.0032         m2/1         0.0032         m2/1         0.0035           Rhizopus nigricans         0.00861         m2/1         0.0082         m2/1         2.57.5         fungi sp         6.28         8.25%           Nocardia asteroides         0.00861         m2/1         0.00661         m2/1         2.67.5         fungi sp         6.28         8.25%           Bocardia asteroides         0.006718         m2/1         0.00664         m2/1         8.02.6         bacteria         1.118         7.89%           Bacillus Cereaspores         0.00512         m2/1         0.00514         m2/1         4.4.98         algae         5.000         4.99%           Pericillium chrysogenum         0.00411         m2/1         0.00434         m2/1         5.6.8         Vegy         4.899         4.03%           Candida abicans         0.00407         m2/1         5.6.8         Vegy         4.899         3.99%           Candida abicans         0.00407         m2/1         5.5.8         Vegy         4.899         3.99%           Gandida abicans <th>Francisella Tularensis</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>	Francisella Tularensis								
Biotypis Ginerea         0.0092         m2/1         0.0092         m2/1         25.03         fungi sp         11.180         8.79%           Nicozon Ginzano         0.00861         m2/1         0.00861         m2/1         0.0861         m2/1         0.0871         m2/1         0.08718         m2/1         0.08718         m2/1         0.00718         m2/1         0.00712         m2/1         0.00407         m2/1         0.00407         m2/1         56.08         Vegt         4.899         3.99%           Candida abicans         0.00407         m2/1         0.00407         m2/1         55.58	Fusarium oxysporum								
Bhizopus Ingricans         0.00861         m2//         0.00861         m2//         26.75         fung sp         6.928         8.25%           Nocardia asteroides         0.00861         m2//         0.00822         m2//         26.82         m2//         26.83         Fung ipi         1.118         5.48%         6.93%         Bacillus Cerceads in M2//         26.86         m2//         40.83         Fung ipi         1.118         5.48%         6.93%         Bacillus Cerceads in M2//         26.84         M2///         26.84         M2///         26.84         M2///         26.84         M2///         26.84         M2///         26.84         M2///         26.84         M2////         26.84         M2////         26.84         M2////         26.84         M2/////         26.84         M2////////         26.83         M2/////////         26.83         M2////////////////////////////////////									
Nocardia sateroides         0.00822         m2/1         0.00822         m2/1         28.02         bacteria         1.118         7.89%           Benillium dirigitatum         0.00718         m2/1         20.018         m2/1         20.011         m2/1         50.018         fung sp         3.622         4.25%         4.25%         4.25%         4.25%         4.26%         4.25%         4.25%         4.25%         4.25%         4.25%         4.25%         4.25%         4.25%         4.25%         4.25%         4.25%         4.25%         4.25%         4.25%         4.25%         4.25%         4.25%         3.29%         Mucor mucedo         0.00407         m2/1         56									
Penciellium digitatum         0.00718         m2/1         0.00718         m2/1         0.00718         m2/1         0.00718         m2/1         0.00564         m2/1         0.00564         m2/1         0.00564         m2/1         0.00564         m2/1         0.00564         m2/1         0.00512         m2/1         0.00512         m2/1         0.00512         m2/1         0.00512         m2/1         0.00434         m2/1         0.00407         m2/1         0.0017									
Bacillus Cereus spores         0.00564         m2/1         0.00564         m2/1         0.008           Algae blue-green         0.00512         m2/1         0.00812         m2/1         0.008           Penicillium chrysogenum         0.00612         m2/1         0.00812         m2/1         0.008           Penicillium chrysogenum         0.00614         m2/1         0.00434         m2/1         0.00431         m2/1         0.00434         m2/1         0.00434         m2/1         0.00434         m2/1         0.00437         m2/1         0.00437         m2/1         0.00437         m2/1         56.58         VegY         4.899 <b>3.99%</b> Candida albicans         0.00407         m2/1         0.00399         m2/1         57.72         fung 5p         7.071 <b>3.91%</b> Candida albicans         0.00386         m2/1         57.72         fung 5p         7.071 <b>3.91%</b> Caddsportum herbarum         0.00344         m2/1         0.00387         m2/1         55.88         bacteria         1.108 <td< th=""><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></td<>									
Algae Blue-green         0.00512         m2/1         0.00512         m2/2         1.005           PericIIIIun Chrysogenum         0.00434         m2/1         0.00434         m2/1         0.00434           PericIIIIun Chrysogenum         0.00441         m2/1         0.00434         m2/1         55.06         fung tp         3.262         4.25%           Trichophyton rubrum         0.00441         m2/1         0.00407         m2/1         55.08         fung tp         4.899         4.03%           Candida albicans         0.00407         m2/1         0.00407         m2/1         55.58         Vegt         4.899         3.99%           Mucor mucedo         0.003399         m2/1         55.58         Vegt         4.899         3.99%           Cadiffspin         0.00407         m2/1         55.58         Vegt         4.899         3.99%           Mucor mucedo         0.003399         m2/1         55.88         Vegt         4.899         3.99%           Gaddsportum herbarum         0.00344         m2/1         0.00357         m2/1         55.88         Vegt         4.899         3.63%           Scopulariopis brevicaulis         0.00344         m2/1         0.00314         m2/1         56.9									
Pencidilium chrysogenum         0.00434         m2/1         0.00434         m2/1         53.06         fungisp         3.262         4.25%           Trichophyton rubrum         0.00411         m2/1         55.08         fungisp         3.262         4.03%           Candida albicans         0.00407         m2/1         56.58         Vegty         4.899         4.03%           Candida albicans         0.00407         m2/1         56.58         Vegty         4.899         3.99%           Candida albicans         0.00407         m2/1         0.00407         m2/1         56.58         Vegty         4.899         3.99%           Candida albicans         0.00407         m2/1         0.00397         m2/1         56.58         Vegty         4.899         3.99%           Cadifa albicans         0.00384         m2/1         0.00355         m2/1         57.72         fungisp         5.060         3.77%           Cadifa spicorium herbarum         0.0037         m2/1         60.55         fungisp         5.063         3.63%           Scopulatopisb trevicalis         0.00344         m2/1         0.0613         m2/1         66.55         fungisp         5.64         1.18         3.05%           Bacil									
Trichophyton rubrum         0.00411         m2/1         0.00411         m2/1         56.03         fung sp         4.899         4.03%           Candida ablicans         0.00407         m2/1         0.00407         m2/1         6.00407         m2/1         6.00407         m2/1         6.00407         m2/1         56.58         VegY         4.899         3.99%           Candida ablicans         0.00407         m2/1         56.58         VegY         4.899         3.99%           Mucor mucedo         0.00389         m2/1         0.00399         m2/1         57.72         fung isp         7.071         3.81%           Cadiffspol         0.003846         m2/1         0.00385         m2/1         59.88         bacteria         0.060         3.77%           Cadiffspol         0.00344         m2/1         0.0037         m2/1         66.95         fung isp         5.916         3.88%           Secultus Anthacis spores         0.00103         m2/1         7.21         bacteria         1.118         3.05%           Aspergillus fungatus spores         0.00103         m2/1         7.23.79         fung isp         5.640         1.02%           Cadoportum wemecki         0.000051         m2/1         0.000	Penicillium chrysogenum								
Candida albicans         0.00407         m2/1         0.00407         m2/1         55.58         Vegy'         4.899         3.99%           Candida albicans         0.00407         m2/1         0.00407         m2/1         6.00407         m2/1         6.00407         m2/1         6.00407         m2/1         6.00407         m2/1         6.0017         m2/1         m2/1         6.0017         m2/1         m2/1         m2/1         m2/1         m2/1         m2/1         m2/1         m2/1         m2/1									
Candida albicans         0.00407 m2/1         0.00407 m2/1         55.58         Veg?         4.899         3.99%           Mucor mucedo         0.00399 m2/1         0.00399 m2/1         55.58         Veg?         4.899         3.99%           Califf sp.         0.003846 m2/1         0.00385 m2/1         55.88         bacteria         0.060         3.77%           Caddsportum herbarum         0.00377 m2/1         0.00387         m2/1         55.88         bacteria         0.660         3.63%           Scopulariopisb brevicaulis         0.00344 m2/1         0.00344         m2/1         66.95         fung sp         5.916         3.83%           Bacillus Anthacis spores         0.00103 m2/1         0.0013         m2/1         223.59         fung sp         5.916         3.83%           Aspergillus fung stores pores         0.00103 m2/1         0.00103         m2/1         223.59         fung sp         5.640         1.02%           Cladosportum wemecki         0.00051 m2/1         0.00058         m2/1         5.037.07         fung is 3.54         0.58%           Cladosportum wemecki         0.00051 m2/1         0.00051 m2/1         6.517.1         fung sp         5.623         0.41%	Candida albicans								
Mucor mucedo         0.00399         m2/1         0.00399         m2/1         57.72         fungi sp         7.771         3.91%           Cladosporium herbarum         0.00376         m2/1         0.00384         m2/1         0.00384         m2/1         0.0037           Cladosporium herbarum         0.00377         m2/1         0.6037         m2/1         62.924         fungi sp         8.062         3.63%           Scopulariopisb trevicaulis         0.00344         m2/1         0.0031         m2/1         66.95         fungi sp         5.016         3.38%           Bacillus Anthicat spores         0.00131         m2/1         0.0231         m2/1         74.29         bacteriai         1.118         3.05%           Aspergillus fungigatus spores         0.00103         m2/1         0.00058         m2/1         20.37.07         fungi sp         5.64         1.02%           Cladosporium wemecki         0.00051         m2/1         0.00051         m2/1         451.57         fungi sp         5.623         0.51%	Candida albicans						VegY		
C.diff sp.         0.003846         m2/l         0.00385         m2/l         55.88         bacteria         0.000         3.77%           Cladosportum herbarum         0.00371         m2/l         0.5037         m2/l         6.031         m2/l         55.88         bacteria         0.060         3.73%           Scopulariopisb hervicaulis         0.00344         m2/l         0.00344         m2/l         66.95         fungi sp         5.916         3.83%           Bacillus Anthacis spores         0.00131         m2/l         1.021         m2/l         50.81         3.05%           Aspergillus fungatus spores         0.00131         m2/l         0.0013         m2/l         23.59         fungi sp         5.84         1.02%           Aspergillus fungatus spores         0.00051         m2/l         0.00138         m2/l         23.59         fungi sp         3.54         0.58%           Cladosportum wemechi         0.00051         m2/l         451.57         fungi sp         5.623         0.41%	Mucor mucedo								3.91%
Cladosportum herbarum         0.0037         m2/l         0.0037         m2/l         62.24         fungi sp         8.662         3.63%           Scopulariopis heroicaulis         0.0034         m2/l         0.0344         m2/l         60.51         fungi sp         5.916         3.38%           Bacillus Anthacis spores         0.0031         m2/l         0.0031         m2/l         74.29         bacteria         1.118         3.05%           Agergillus fungatus spores         0.0013         m2/l         0.0030         m2/l         20.359         fungi sp         2.640         1.02%           Agergillus fungatus spores         0.00051         m2/l         0.00058         m2/l         397.07         fungi         3.354         0.58%           Cladosportum wernecki         0.00051         m2/l         0.00051         m2/l         451.57         fungi sp         5.622         0.5196           stachybotrys-chartarum         0.000051         m2/l         451.571         fungi sp         5.622         0.4196	C.diff sp.								
Scopulariopsis brevicauits         0.00344         m2/1         0.00344         m2/1         66.95         fungisp         5.916         3.38%           Bacillus Antidas spores         0.00314         m2/1         0.013         m2/1         7.429         bacteriai         1.118         3.05%           Agergillus fundigatus spores         0.00103         m2/1         7.429         bacteriai         1.118         3.05%           Agergillus fundigatus spores         0.00103         m2/1         0.00058         m2/1         9.00058         m2/1         9.00163         m2/1         1.028           Cladosportum wemechi         0.00051         m2/1         0.00051         m2/1         451.57         fungisp         5.623         0.013%           stachybotrys-chartarum         0.000051         m2/1         6.00051         m2/1         451.71         fungisp         5.623         0.413%	Cladosporium herbarum			0.0037		62.24		8.062	3.63%
Aspergillus fumigatus spores         0.00103         m2/J         0.00103         m2/J         223.59         fungi sp         2.640         1.02%           Aspergillus niger spores         0.00058         m2/J         0.00058         m2/J         397.07         fungi sp         3.54         0.58%           Cladosporium wemecki         0.00051         m2/J         0.00051         m2/J         451.57         fungi sp         8.062         0.51%           stachybotrys-charatrum         0.00051         m2/J         561.71         fungi sp         5.623         0.41%	Scopulariopsis brevicaulis	0.00344	m2/J	0.00344				5.916	
Aspergillus niger spores         0.00058         m2/J         0.0058         m2/J         397.07         fungi         3.35.4 <b>0.58%</b> Cladosporium wemecki         0.00051         m2/J         0.0058         m2/J         451.57         fungi p         8.062 <b>0.51%</b> stachybotrys-charatrum         0.00041         m2/J         0.40041         m2/J         56.71         fungi p         5.623 <b>0.41%</b>	Bacillus Anthacis spores						bacteria		
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stachybotrys chartarum 0.00041 m2/J 0.00041 m2/J 561.71 fungisp 5.623 0.41%	Aspergillus niger spores								
	Cladosporium wemecki								
Moraxella 0.00022 m2/J 0.00022 m2/J 1046.82 bacteria 1.225 0.22%									
	Moraxella	0.00022	m2/J	0.00022	m2/J	1046.82	bacteria	1.225	0.22%

# Photos of the Red Meat HVAC Air Handling Unit RR11 After Two Month's Exposure to the Puradigm

No Black Mould has grown on any of the many surfaces of the AHU ductwork in the two months of exposure to the Puradigm technology.















It is expected that the *black mould will continue to be limited in the air and on surfaces within the Air Handling Unit*. As such the frequency of cleaning can be reduced and thus the *use of chemicals and their associated labour and material costs will be reduced* while retaining the high hygiene standards that is typical of Coles manufacturing environments.

The next steps would be to roll out these Puradigm HVAC units into all of the plant AHUs.

### 7.2 Fresh primals – Microbiological Reduction Trials over short time frames

Having shown the significant microbial reductions, on the surface of 35 day aged primals, in previous milestones, with 2-4 log reductions achieved over periods of 8hrs or more in very cold and high, opposing air flow environments, this final milestone will focus on *fresh primals, aged for 10 days* or less. The estimated speed of reduction in the previous milestone, using the fastest reduction speeds measured for the very contaminated primals, showed fresh primals should be able to be *decontaminated in the order of several minutes*.

The environment is once again a 4C, cool room, with high, opposing air flow conditions.

One Puradigm PRO was utilised for this trial, whose output was measured at 300K ions/cc near the unit as shown below.



A fresh primal of Cube roll was supplied on the Thursday and the test was run on the following Monday morning. *The primal is aged 10 days*.

The cube roll was cut open and immediately swabbed at Time = 0 minutes at two locations on the face of the roll as shown below.





The following sample schedule was the followed for the next set of sample swabs at the same locations on the cube roll face.

Sample Left	Sample Right	Time (mins)	
1	0	0	
3	2	5	
5	4	10	
7	6	15	
9	8	30	
11	10	120	
13	12	240	
15	14	360	

Right sample swab location

Left sample swab location







Location of Trial Equipment within the Cool room

Sample Swabs after Trial



#### **ALS Lab Submission**

	FOOD MIC	ROBIOLOG	GY	-	SA	MP	LES	SUB	MI	SSIC	DN	FOR	M							Office use only:
	Company Name:				Retail Ready Operations Australia															
ALS	N	Contact			Sheet	al M	laha	raj												Date:
Food Pharmace	Food & Pharmaceutical Street Address:				54 Templar Road Erskine Park NSW 2759										Print & Email to ALS	Time:				
		Email			Sheet	al.N	1aha	raj@	col	es.co	om.a	u								Condition:
		Address:																		condition.
60/000 11 01 0 1	1 10111	Phone:	_	1	0437 9						-						_			
Purchase Order No.	2/05/23		1 1	Special instructions:       Limits of test as <10cfu/swab         Date start: 01/05/2023					ads											
Sample Name										Т	'esti	ng F	Requ	ireo	l (pl	ease	e tic	k tes	sts required)	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Other (pl	ease specify)
Sample 0. T= Omin				х																
Sample 1. T= Omin				x									<u> </u>					<u> </u>		
Sample 2. T= 5mins				X														-		
Sample 3. T= 5mins				x x							<u> </u>							<u> </u>		
Sample 4. T= 10mins				x																
Sample 5. T= 10mins Sample 6. T= 15mins				x										-						
Sample 7. T= 15mins				x										-						
Sample 8. T= 30mins				x																
Sample 9. T= 30mins				x																
Sample 10. T= 2hrs				х																
Sample 11. T= 2hrs				х																
Sample 12. T= 4hrs				х																
Sample 13. T= 4 hrs				х																
Sample 14. T= 6hrs				х																
Sample 15. T=6hrs				х																
Do you require a sepa	rate report fo	r each samp	le:													Sai	mple	es to	be composited:	

Test No.	Test Description	Test No.	Test Description	Test No.	Test Description
1	Standard Plate Count - food and dairy	7	E.coli – PETRIFILM <10	13	Enterobacteriaceae Enumeration
2	Standard Plate Count - Raw Meat and Fish	8	Coliforms - PETRIFILM <10	14	Coagulase Positive Staph - Enumeration
3	Yeast & Mould Enumeration	9	Coliforms Enumeration	15	Coagulase Positive Staph - Presence / Absence
4	Listeria Detection ELISA	10	Salmonella Detection ELISA	16	Clostridium Perfringens Enumeration
5	E.coli - MPN <3	11	Salmonella Detection AS		

### ALS Microbiological Results

			S. Marting			1
Cortif	icate of Analysis		lac	MRA	NA	TA
	-					
Retail Ready Operation: 20 Box 97 St Clair NSW, 2759	s Australia Pty Ltd		Talula 1	Accredi	Accreditation ted for complia ISO/IEC 17025	ance wit
Attention: Sheetal Ma	aharaj					
Overall Description:	Dradiam Freeb Test on Drime	Surface on	irmonmontol Elovi Sur	aha Data St	ort: 01/05/2	
Overall Description. Our Ref No:	Pradigm Fresh Test on Primal FS2323774	Surface env	Your Ref: 2/05/23	ins, Date St	art. 01/05/2	.5
Project:	102020114		Report Date: 09 May	2023		
Samples Received:	02 May 2023		Temperature when re		c	
Testing Commenced:	03 May 2023				0	
	produced except in full, without without without into the laboratory, unless the					
ample Details: Test Descri	ption		Results		Units	Site
	in (NATA Accredited)					
FM0010	Aerobic Plate Co	unt		~90	CFU/swab	NSM
002 Sample 1. T= 0m FM0010	in (NATA Accredited) Aerobic Plate Col	unt		360	CFU/swab	NSV
	ins (NATA Accredited)			300	Ur UrawaD	1101
FM0010	Aerobic Plate Co	unt		~30	CFU/swab	NSV
	ins (NATA Accredited)					
FM0010	Aerobic Plate Co	unt		~20	CFU/swab	NSV
	nins (NATA Accredited)				OFU	10
FM0010	Aerobic Plate Con nins (NATA Accredited)	unt		<10	CFU/swab	NSV
FM0010	Aerobic Plate Co	unt		<10	CFU/swab	NSV
007 Sample 6. T= 15r	nins (NATA Accredited)					
010 Sample 9 T= 30r	nins (NATA Accredited)	. J.				
FM0010	Aerobic Plate Cou	Int		<10	CFU/swab	NSW
011 Sample 10. T= 2h	nrs (NATA Accredited)					
FM0010	Aerobic Plate Cou	int		<10	CFU/swab	NSW
	nrs (NATA Accredited)				0511	1004
FM0010	Aerobic Plate Country (NATA Accredited)	int		<10	CFU/swab	NSW
FM0010	Aerobic Plate Cou	Int		<10	CFU/swab	NSW
	hrs (NATA Accredited)					
FM0010	Aerobic Plate Cou	int		<10	CFU/swab	NSW
	nrs (NATA Accredited)					
FM0010	Aerobic Plate Cou	int		<10	CFU/swab	NSW
	ISW - 1247 (site: 2040) VIC ISW - MI-2012 - LI - 05733 - 3 VIC - ISW - 6179 VIC 10/2-8 South Street, Rydalmere N	MI-2012 - LI - 6181	06776 - 3	te: 25153)		
Right Solutions · Rig	Food & Pharmaceu	Itical. An ALS Li	nited Company		alsgloba	Lcom
agin oolutions rag		ruge r or z			alsgloba	1.0011
Dur Ref No :FS23237 Report Date:09 May 20			Your Ref: 2/05/2	23		
016 Sample 15 T=6h	rs (NATA Accredited)					
FM0010	Aerobic Plate Cou	Int		<10	CFU/swab	NSW
IATA accreditation does not cover t easurement of Uncertainty values f			ies.			1
ignatories						
	ctronically signed by the authorized si nce with procedures specified in 21 CF		ated below. Electronic signin	ng has		
Signatories	Position	,	Accreditation Category			



#### **Conclusion of Results**

The fresh cube roll primal was tested at 10 days aged. The baseline aerobic plate count at 0 minutes on the left and right sides of the primal facing the Puradigm unit were measured at 360 and 90 counts.

After *5 minutes* the plate count had reduced **67-94% (1 Log reduction)** and after **10 minutes** the plate counts were undetectable ie **100% reduction** and remained so at 15, 30, 120, 240 and 360 minutes.



#### **Practical Applications**

This fresh primal trial demonstrates how the Puradigm technology can be applied in *several practical ways at both primary and secondary processing facilities.* 

Primary processors currently use chemical washes to *clean carcases*. However while the carcase is hanging in the cool rooms, being tested and then portioned, there are numerous points pathogens are introduced to the surface of the carcase and its portions as the products is being handled. Utilising the Puradigm technology can *reduce these pathogens as they are being introduced* and avoid them getting a foothold from which they multiply into significant numbers.

Secondary processing have very clean equipment and tools with which they process the incoming primals into the finished goods. However if the incoming primal surfaces are covered in bacteria after several days of aging, these bacteria will be introduced into each portion through the cutting and other processing actions and these bacteria will eventually multiply despite the packaging environments and temperatures that the finished goods are transported and stored within. The Puradigm technology can be utilised to *minimise the surface bacteria from debagging through portioning and into packaging*, which will *extend the shelf life* of the finished product.

Since the Puradigm output is *a natural intervention, containing only water and charged ions*, this intervention *doesn't damage the DNA* of the meat and thus doesn't change the taste of the product.

There is no excessive drying out of meat above that which is already occurring due to the air flow in the cool rooms while the carcases are hanging. During portioning at either primary or secondary processing, it is only short duration exposures so there is no significant drying of the primals. Additionally the use of dry fog humidifier sprays will not only maximise the effect of the Puradigm output but will also ensure the meat is kept from drying out.

#### **Primals – Microbiological Reduction Trial Summary**

Puradigm's natural intervention was shown to generate surface plate count reductions of **2 log** (99%) in 24hrs and 4 log (99.99%) in excess of 24hrs for heavy micro-loads in 35 day aged primals with starting (baseline) plate counts over 100 million.

Primal Age	2-24hr (Log	2-24hr (%	24-144hr (Log	24-144hr (%
	Reduction)	Reduction)	Reduction)	Reduction)
35 days	2	99	4	99.99

For carcases hanging in cool rooms for 24hrs or more, or primals and portions exposed for 24hrs or more, these results are very significant, given their starting bacterial loads will be more in the order of a *few hundred plate counts*, which Milestone 6's results show are able to be significantly *reduced in a matter of 5-10 minutes*.

### 7.3 Packaging Decontamination – Final report on effectiveness

Puradigm's air and surface purification was shown to be *unsuitable for pathogens submerged in water*. This is a known limitation. Thus packaging, which is possibly contaminated but wet, will not experience significant reductions in micro-load when exposed to Puradigm's technology during short term exposures.

However for dry packaging, this technology is suitable, as can be seen through the primal reduction trials. It should be noted that primals are a greater challenge when compared to dry packaging, given primals are moist and contain nutrients that promote bacterial growth.

#### Puradigm's units are being deployed to the Dry Packaging Decontamination room at Chef Fresh.

It should be noted that only exposed surfaces will be purified, and thus for packaging to be adequately decontaminated, each packaging bag should be placed on racks which allow air to circulate fully around the bag, and be left in the room for at least 10 minutes, with best results obtained for exposures 4hrs or more, depending on how contaminated the surfaces have become.

#### 7.4 Puradigm and Denba – Next Steps

A separate MLA MDC has been submitted to run the investigation of the combination of Puradigm and Denba technologies as a separate project. It is expected that both technologies being **natural technologies**, with **Puradigm removing surface pathogens and Denba slowing internal pathogens**, **shelf-life of the product will be maximised** without changing the texture or taste. Both technologies have extremely low power requirements, and in fact can significantly reduce the energy required for frozen applications, and are thus not only natural and safe, but also sustainable.

### 7.5 Next Steps

*Trials in supermarkets and primary processing* to investigate optimal implementation strategies for all the benefits this technology has shown to provide, such as shelf-life extension, odour reduction, continuous and safe purification of air and surfaces for the protection of people and products.

Further research aimed at incorporating the technology into **MAP packaging, odour control in waste** management, equipment cleaning, transportation of fresh produce, transportation sanitation for mould control, and combined applications with Denba to provide additional microbial reductions/control for enhanced shelf-life of products, reduced energy consumption for frozen products and enhance frozen products to fresh or sashimi-grade on defrosting, should be conducted.

This project has confirmed that Puradigm represents a paradigm shift in purification, promising a wide range of benefits to all industries, including the red meat industry.

### 8 Success in meeting the Milestone

### 8.1 Milestone 1

Milestone 1 has been successfully completed through the development of the design and detailed work testing schedule. The initial phase will evaluate the effectiveness of the air and surface purification technology through pilot testing against various microbial loads in the Chef Fresh packaging material decontamination rooms (ozone rooms), the RROA HVAC Air Handling Units and RROA Primal shelf-life trials.

This milestone 1 has involved the design of trials & testing methodologies, evaluation of safety aspects and development of operating protocols for the purification technology. Test units were procured from the supplier. A detailed project testing schedule was developed. The project steering group was formed. The progress report on design and detailed project schedule was submitted to the project steering group & approved by the MLA. The outcomes of the pilot studies will be used to inform and develop detailed work plans for the next commercial proving phases.

### 8.2 Milestone 2

Milestone 2 has been successfully completed through practical trials and initial testing in a production environment, including:

- Microbiological reductions on packaging material within old ozone rooms
- Analysis of environmental conditions and design to maximise Ion efficiencies in new and old ozone rooms
- Preparation of HVAC tests through the installation of HVAC devices within the air handling units
- Preparation of the Shelf-life tests through 24hr microbiological reduction tests for beef primal surfaces

### 8.3 Milestone 3

Milestone 3 has been successfully completed through practical trials and initial testing in a production environment, including:

• Shelf-life tests through 24hr, 72hr, 96hr, 144hr and 0-24hr at 2hr interval, microbiological reduction tests for beef primal surfaces at varying distances, under 4C temperatures and strong room air flows.

### 8.4 Milestone 4

Milestone 4 has been successfully completed through:

- Microbiological reduction speed tests for fresh, non-aged beef primal surfaces, under 4C temperatures and strong room air flows.
- HVAC trials in Air Handling Units, in extremely high speed air currents
- Puradigm and Denba combined shelf life extension trials

### 8.5 Milestone 5

Milestone 5 has been successfully completed through:

- Microbiological reduction final report on effectiveness in various conditions and timeframes.
- Results for HVAC trials in Air Handling Units, for extremely high speed air currents
- Puradigm and Denba combined shelf life extension trials
- Packaging decontamination final report on effectiveness

### 9 Conclusions & Recommendations

### 9.1 Conclusions

Milestone 1, 2, 3, 4 & 5 have been successfully completed through the development of the design and detailed work testing schedule and implementation in a production environment at RROA's HVAC AHUs and Quality testing rooms for shelf-life trials with red meat primals.

### 9.2 Recommendations

The project proposes to accept this final public report for Milestone 5 and publish on the MLA portal for wider industry benefit.

### **10** APPENDIX - Supporting Documents

10.1 Appendix 1 Coles Group - Vision, Purpose & Strategy

Our purpose. Sustainably feed all Australians to help them lead healthier, happier lives.

2. Smarter selling through efficiency and pace of change. 3. Win together with our team members, suppliers and communities.

1. Inspire customers through best value food and drink solutions to make lives easier.

### **10.2** Appendix 2 – Certifications

### Organic Certification – Washington State Department of Agriculture

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In accordance with Chapter 15.86 RCW and Chapter 16-190 WAC Washington State Department of Agriculture <b>MATERIAL REGISTRATION</b> <b>DEPARTIENT OF AGRICULTURE</b> Bissued to: Puradigm LLC 11440 W. Bernardo Court San Diego, CA 92127 United States The products listed below have been verified to comply with the USDA National Organic Standards (7 CFR Part 205): <u>The Product Name</u> <u>Sub-Type Information</u> 314 PURADIGM GROW Hydrogen Peroxide DPC Preventative practices must be implemented prior to use. Types: CPA - Crop Production Aid, DPC - Disease and Pest Control, FSA - Fertilizer and Soil Amendment, LPA - Livestock Production Aid, PH - Processing and Handling WSDA Registered Company #: 945 Issue Date: 09/08/2020 Registration valid through 10/31/2021 Jund Jack Brenda Book Organic Program Manager DEPARTMENT OF AGRICULTURE			$\sim$	>						
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San Diego, CA 92127 United States         The products listed below have been verified to comply with the USDA National Organic Standards (7 CFR Part 205):         #       Product Name       Sub-Type       Type       Annotation         3314       PURADIGM GROW       Hydrogen Peroxide DPC       Preventative practices must be implemented prior to use.         Types: CPA - Crop Production Aid, DPC - Disease and Pest Control, FSA - Fertilizer and Soil Amendment, LPA - Livestock Production Aid, PH - Processing and Handling         WSDA Registered Company #: 945 Issue Date: 09/08/2020 Registration valid through 10/31/2021       Sauch       Sauch         Brenda Book Organic Program Manager DEPARTMENT OF AGRICULTURE       Brenda Book, Organic Program Manager       Sauch Agriculture										
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**Ozone Safety** 

### TEST CERTIFICATE ISSUED BY THE FOOD SCIENCE INSTITUTE, KANSAS STATE UNIVERSITY



### OZONE SAFETY TEST FOR THE PURDIGM AIR HVAC 14 INCH AIR PURIFICATION SYSTEM

Manufacturer:	Puradigm, LLC 720 S. 7 <sup>th</sup> St. 3rd Floor Las Vegas, NV 89101		
Model or Type Identification:	Puradigm Air HVAC 14 inch		
Sample Delivery Date:	9 <sup>th</sup> October 2012		
Tests Conducted Between:	17 <sup>th</sup> and 19 <sup>th</sup> October 2012		

The Food Science Institute at Kansas State University has tested the above Puradigm Air HVAC 14 inch duct mounted advanced oxidation air purification system, evaluating ozone levels in a room environment with the output set per manufacturer's instructions. Test results showed maximum equilibrium concentration of ozone below 0.05 ppm.

The National Ambient Air Quality Standard, established by the U.S. Environmental Protection Agency (EPA) is .08 ppm for outdoor ozone. National Institute of Occupational Safety and Health recommendations and Occupational Safety and Health Administration regulations both establish ozone levels of 0.10 ppm as the safety threshold for workers on the job. The most stringent standard, those of the U.S. Food and Drug Administration for indoor medical devices, specifies that ozone output be no more than 0.05 ppm.

Based upon tests performed and international safe standards for ozone exposure, the ozone levels produced by the tested purification system pose no risk to building occupants.

. L. Mart

James L. Marsden, Ph.D. Distinguished Professor Food Safety & Security

Dated 22<sup>nd</sup> October 2012

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Page 1 of 1

Certificate No: FSI 58D215

Food Science Institute Kansas State University, 216 Call Hall Manhattan, KS 66506 Phone: (785) 532-4057 Fax: (785) 532-5861 Hydrogen Peroxide Safety

### TEST CERTIFICATE ISSUED BY THE FOOD SCIENCE INSTITUTE, KANSAS STATE UNIVERSITY



### HYDROGEN PEROXIDE TEST FOR THE PURDIGM AIR HVAC 14 INCH AIR PURIFICATION SYSTEM

Manufacturer:	Puradigm, LLC 720 S. 7 <sup>th</sup> St. 3rd Floor Las Vegas, NV 89101			
Model or Type Identification:	Puradigm Air HVAC 14 inch			
Sample Delivery Date:	9 <sup>th</sup> October 2012			
Tests Conducted Between:	17 <sup>th</sup> and 19 <sup>th</sup> October 2012			

The Food Science Institute at Kansas State University has tested the above Puradigm Air HVAC 14 inch duct mounted advanced oxidation air purification system, evaluating gaseous Hydrogen Peroxide (H2O2) levels produced by the purifier in a room environment with the output set per manufacturer's instructions. Test results showed hydrogen peroxide levels remained below 0.05 ppm.

OSHA's permissible exposure limit (PEL) for gaseous hydrogen peroxide is 1.0 ppm (continuous) over 8-h work shifts.

The gaseous hydrogen peroxide levels produced by the purification system are over 20 times below the permissible exposure limit. Based upon tests performed and international safe standards, the gaseous hydrogen peroxide produced by the tested purification system pose no risk to building occupants.

free L. Mark

James L. Marsden, Ph.D. Distinguished Professor Food Safety & Security

Dated 22<sup>nd</sup> October 2012

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Page 1 of 1

Certificate No: FSI 58D211

Food Science Institute Kansas State University, 216 Call Hall Manhattan, KS 66506 Phone: (785) 532-4057 Fax: (785) 532-5861

Page 100 of 102

### Summary of Test Results

## Puradigm Test Results Summary



	Surface	Reductions
Pathogen	Reduction	Testing Organization
Acinetobacter baumannii	98.22%	Ankara Oncology Hospital
Aspergillus brasiliensis	84.15%	UC Colorado Hospital
Bacillus atrophaeus	99.81%	Kansas State University Food Science Institute
Bacteria	99.45%	Institut Jantung Negara PICU Malaysia
Bacteria	99.98%	Quadrants Scientific Inc - Golds Gym
Bacteria	99.63%	Quadrants Scientific Inc - Nail Salon
C. Diff	99.53%	NSF international Lab
Candida albicans	99.99%	Kansas State University Food Science Institute
CRE	99.98%	Kansas State University Food Science Institute
Coronavirus 229E	99.00%	Central Michigan University College of Medicine
COVID 19 (SARS-CoV-2)	97.70%	University of Florida College of Medicine
COVID 19 (DELTA Variant)	99.78%	Australia Government Lab
Dengue virus type 2	99.00%	Central Michigan University College of Medicine
E. coli	99.59%	Kansas State University Food Science Institute
E. coli	99.99%	Ministry of Healthcare of Ukraine
E. coli O157:H7	99.41%	Kansas State University Food Science Institute
Enterococcus faecalis	99.99%	Ministry of Healthcare of Ukraine
Fungus	99.99%	Ministry of Healthcare of Ukraine
H1N1	99.60%	Guangdong Detection Center of Microbiology
Legionella	99.99%	Kansas State University Food Science Institute
Listeria monocytogenes	99.87%	Kansas State University Food Science Institute
Mold	89.00%	Ultimate Labs
MRSA	99.24%	Kansas State University Food Science Institute
Pseudomonas aeruginosa	74.88%	UC Colorado Hospital
Pseudomonas aeruginosa	99.54%	Kansas State University Food Science Institute
Stachybotrys chartarum	99.99%	Kansas State University Food Science Institute
Staphylococcus aureus	99.99%	Ankara Cancer Education and Research Clinic Turkey
Staphylococcus aureus	99.15%	Kansas State University Food Science Institute
Staphylococcus aureus	99.90%	Pontiac General Hospital
Staphylococcus aureus	74.88%	UC Colorado Hospital
Staphylococcus epidermidis	99.99%	Ministry of Healthcare of Ukraine
Streptococcus pneumoniae	98.83%	Kansas State University Food Science Institute
Total Aerobic Count	66.49%	Meat Production Plant
Total Coliforms	93.88%	Meat Production Plant
VRE	98.22%	Ankara Oncology Hospital

### **Puradigm Test Results Summary**



#### Air Reductions VOC Reduction Testing Organization Acetaldehyde 96.00% Hye-sung Environment Inc. Korea Acetone 97.81% Ministry of Healthcare of Ukraine Acetone 89.75% Atmospheric Analysis-Consulting 82.90% Ammonia Guangdong Detection Center of Microbiology Ammonia 93.00% Hye-sung Environment Inc. Korea 97.57% Ammonia Ministry of Healthcare of Ukraine Bacteria 95.50% Ultimate Labs Guangdong Detection Center of Microbiology Benzene 80.00% 97.00% Butanone Hye-sung Environment Inc. Korea Butyraldehyde 87.00% Hye-sung Environment Inc. Korea Carbon Disulfide 99.99% Atmospheric Analysis-Consulting COVID 19 (BETA Variant) 98.70% University of Florida College of Medicine 71.00% Dimethyl Disulfide Hye-sung Environment Inc. Korea 87.00% Dimethyl Sulfide Hye-sung Environment Inc. Korea Formaldehyde 81.10% Guangdong Detection Center of Microbiology 97.00% Hydrogen Sulfide Hye-sung Environment Inc. Korea i-Valeric Acid 94.00% Hye-sung Environment Inc. Korea Methyl isobutyl ketone 99.99% Hye-sung Environment Inc. Korea Mold 99.99% Ultimate Labs n-Butyric Acid 98.00% Hye-sung Environment Inc. Korea n-Valeric Acid 69.00% Hye-sung Environment Inc. Korea 60.69% Propanol (IPA) Atmospheric Analysis-Consulting 99.99% Propene Atmospheric Analysis-Consulting 92.00% Propionaldehyde Hye-sung Environment Inc. Korea Propionic Acid 75.00% Hye-sung Environment Inc. Korea Styrene 86.00% Hye-sung Environment Inc. Korea Toluene 99.00% Hye-sung Environment Inc. Korea Toluene 99.99% Atmospheric Analysis-Consulting Total VOC 83.20% Guangdong Detection Center of Microbiology Trimethylamine 93.00% Hye-sung Environment Inc. Korea Xylene 95.00% Hye-sung Environment Inc. Korea