Final Report

Carton Handling and Storage Best Practice Guide for Small to Medium Smallstock Processors

For the Australian Meat Processing Industry

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AMPC and NIRAS acknowledge the Traditional Custodians of the land on which we gather and meet, and pay our respects to their Elders past, present and emerging and extend that respect to all Aboriginal and Torres Strait Islanders people.

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Executive Summary

The Australian Meat Processing Cooperation (AMPC) and NIRAS Australia Pty Ltd (NIRAS) have collaborated to developed a Best Practice Guide for carton handling and storage, specifically for small to medium scale smallstock abattoirs and boning facilities. These are defined as facilities that bone between 456 - 3420 carcases per day . This guide book focuses on best practice and cost-effective solutions in order to resolve and overcome many challenges within the industry such as labour shortage, lifting and repetitive strain injuries, energy cost increases, labour cost increases, forklift interaction risks, carton handling issues and carton & pallet presentation issues. The Guide also details gaps in the market place, where cost effective solutions are currently not available or viable, in order to drive technology and innovation in these areas and further support the industry as a whole.

Although participation in the project was made more difficult due to impacts of COVID outbreaks and restrictions, the participation, enthusiasm and the desire for value outcomes from the industry were evident in all our conversations and meetings. We would like to thank each of the following organisations whose involvement helped shape this project:

- M.C. Herd VIC
- Tallangatta Meat Processors VIC
- McPhee's Export Meats Pty Ltd VIC
- Gathercole's VIC
- Wagstaff VIC
- L&G Meats VIC
- Hillside Meats WA
- Dardanup Butchery Company WA

This Best Practice Guide provides an overview of current solutions and the latest technology available in the world in order to assist small to medium size facilities achieve best in class performance. Many of these solutions are inspired by industry. In numerous cases organisations have overcome issues common to many, and in other cases, this Guide has identified cost effective solutions that could be implemented industry wide to overcome more universal issues.

Available technologies and options have been graded against the challenges and obstacles highlighted by the industry. Each solutions looks to streamline the processes and ensure a safer and more efficient and effective environment for their operators, team leaders and supervisors. By implementing the correct training and technology, the following can be achieved:

- Attract and retain skilled team members and more reliable staff;
- Reduce electricity costs;
- Reduce labour requirements;
- Improve carton and pallet presentation;
- Free up space in the cold store for better forklift and pedestrian segregation;
- Reduce manual handling, and occupational, health & safety issues;
- Prevent property damage, and
- Improve product quality.

Introduction

In 2020, AMPC approached several industry participants as part of their Advance Manufacturing Research & Development Program to develop a list of themes which the participants then voted on, added to or deleted. One of the themes that was highlighted as an area of concern for small to medium size facilities was the carton handling and storage functions. An initiative within carton and materials handling area was to identify alternatives to existing ways of product movement. This was further detailed, in last year's AMPC **2020-2021 Annual Operating Plan**[1] where AMPC had specified that their role in this area is to ensure that there was improved safety for workers who engage in manual handling tasks and thus, out of this, the Best Practice Guide project for carton handling and storage was born.

The objective of this project was to engage with small to medium size processors in the smallstock industry, that is facilities that bone between 456 - 3420 carcases per day, and gather data on their current performance and issues in regards to safety, quality, production efficiency and process flow. This process was used to understand what challenges the industry was experiencing, in order to build a guidebook that promotes practices and methodologies that could directly help the industry to improve their efficiency and reduce their occupational health and safety risks.

The project commenced in early 2021. COVID restrictions limited travel and created constraints over data capture methodology. The review of current site operations, activities and storage methods were completed via video meetings and data exchanges until restriction easing allowed access to sites.

The latest technology, options and solutions were then graded to understand how effective they would be at resolving the common challenges. Each technology, option and solution aims to address occupational health and safety and quality risks using the highest hierarchy of control. This guidebook has both low and high capital investment options. Although some solutions do require significant capital investment, they are still potentially feasible and viable for small to medium size facilities. Furthermore, they have the ongoing benefit of streamlining processes, removing labour intensive tasks, reducing operational costs, improving carton presentation, reducing property damage and reducing errors.

Why this Guidebook?

This Guidebook is a go to document for all small to medium size smallstock abattoirs and boning facilities with the desire to optimise and improve their carton handling and storage practices. Contained in this document are details of contemporary solutions and the latest technology available throughout the world that will help small to medium size facilities achieve best in class performance.

In doing so this Guidebook provides following:

- Education to AMPC processors and providers on what is best practice and how to achieve it, and
- Documentation of possible training, software and technology solutions applicable now and in the future.

[1] (AMPC, 2021)

Methodology

To assist the Australian Red Meat Industry in developing a Best Practice Guide, a number of stages were actioned. This included engaging with processors to ascertain the various challenges they were facing and establishing baseline operations for each site. This was followed by quantified grading of the issues detailed by the industry to ensure corresponding recommendations, solutions and identification of significant issues that may not have a feasible solution. Possible technologies, training and software solutions have be referenced in this enclosed Best Practice Guide.

Stage 1 – Site Studies and Data Gathering

- Work with a range of small to medium smallstock processors within Australia,
- Review current site operations, activities and storage methods on site and over teams meetings,
- Brief and manage site investigations including product surveys, and process equipment capacity and time studies.

Stage 2 – Completion of Technology and Options Analysis

- Evaluate, compare, and interpret data collected from small to medium smallstock processors within Australia,
- Grade all issues in terms of severity and consequence,
- Determine applicable technology and method that can mitigate common issues,
- Evaluate solution with existing practices and feasibility,
- Procure estimated costing for solution.

Project Outcomes

NIRAS has prepared a **Schedule of Technologies and Options** that will assist small to medium size operations improve their performance and safety. Many of these technologies and options have come from the industry itself and much of this Guidebook is a consolidation of Best Practices already being achieved by some parts of the industry. As every site is different, the most cost effective solutions will vary for each individual site and thus it is important to complete a thorough master plan to determine which solutions will present the best payback. **The technologies and options contained in the guide can provide for significant savings for small to medium size processors, these savings are in the realm of $800k to $2.5m per annum and a simple payback of between 2.5 - 4 years.** This is a Guidebook to reference for the most up to date technologies and options. As detailed, the most beneficial solutions will vary for each site and it is important to complete a thorough review before determining which solution is best for your site. We hope the guide helps you understand what solutions are out there, what price range they come in and what their benefits and limitations are.

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Common Themes in the Industry

Referring to Chart 1 on the following page is a list of all the major issues highlighted by the industry participants during the site studies and data gathering process. **One of the most significant themes brought up by the industry was the soft tissue and repetitive strain injuries from sorting and palletising cartons, loading cartons into stillages, lifting cartons into blast freezer racking, and reworking pallets.** Furthermore, it was evident that staff shortages and staff retention was also a common issue in the carton handling and storage area. An issue made more challenging in a COVID environment. With cold store conditions and the sometimes physical manual handling requirements, many processors have expressed concern with finding and retaining staff to operate within this area.

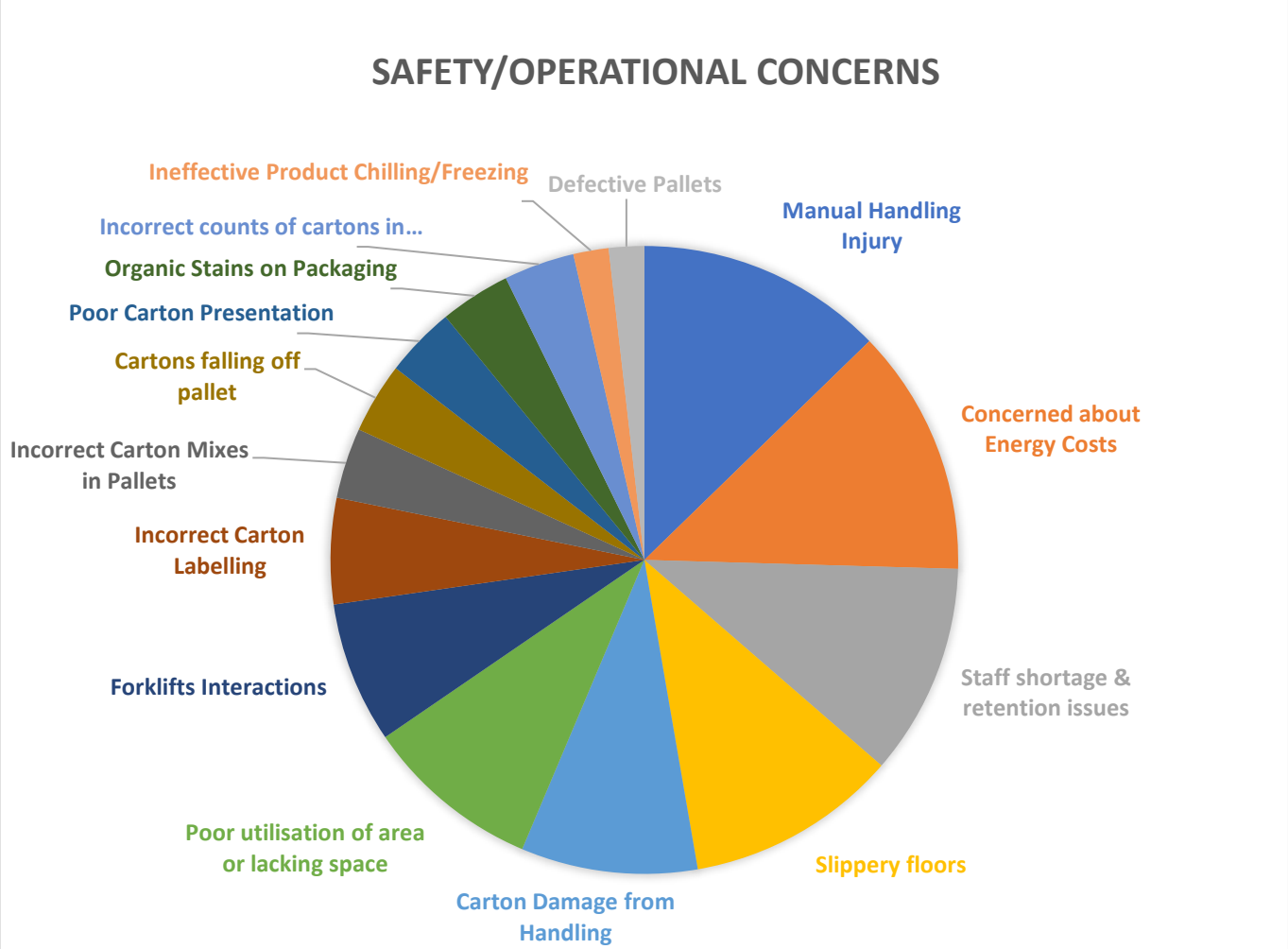


CHART 1 – SAFETY AND OPERATIONAL CONCERNS AND THEMES FROM THE SITE STUDY AND DATA GATHERING PROCESS

Other issues and concerns highlighted include increasing energy costs, slippery floors, building footprint limitation issues, carton damage, property damage, product rework issues, many quality issues, and carton/pallet presentation issues.[2] During the technology and solutions analysis, all these issues were graded in terms of consequence and frequency and a holistic process was taken to understand what technology and options could be adopted by the industry to overcome these industry wide challenges.

Baseline Operation

The average cartons per operator hour is a key performance indicator of efficiency for each small to medium size smallstock processor. Chart 2 below details the resource cost in the carton handling and storage areas. This includes supervisors, quality control team members, and operators handling of finished goods post boning operations (once in a carton) and up to the loadout docks.

[2] Data and graphs can be found in Appendix 1

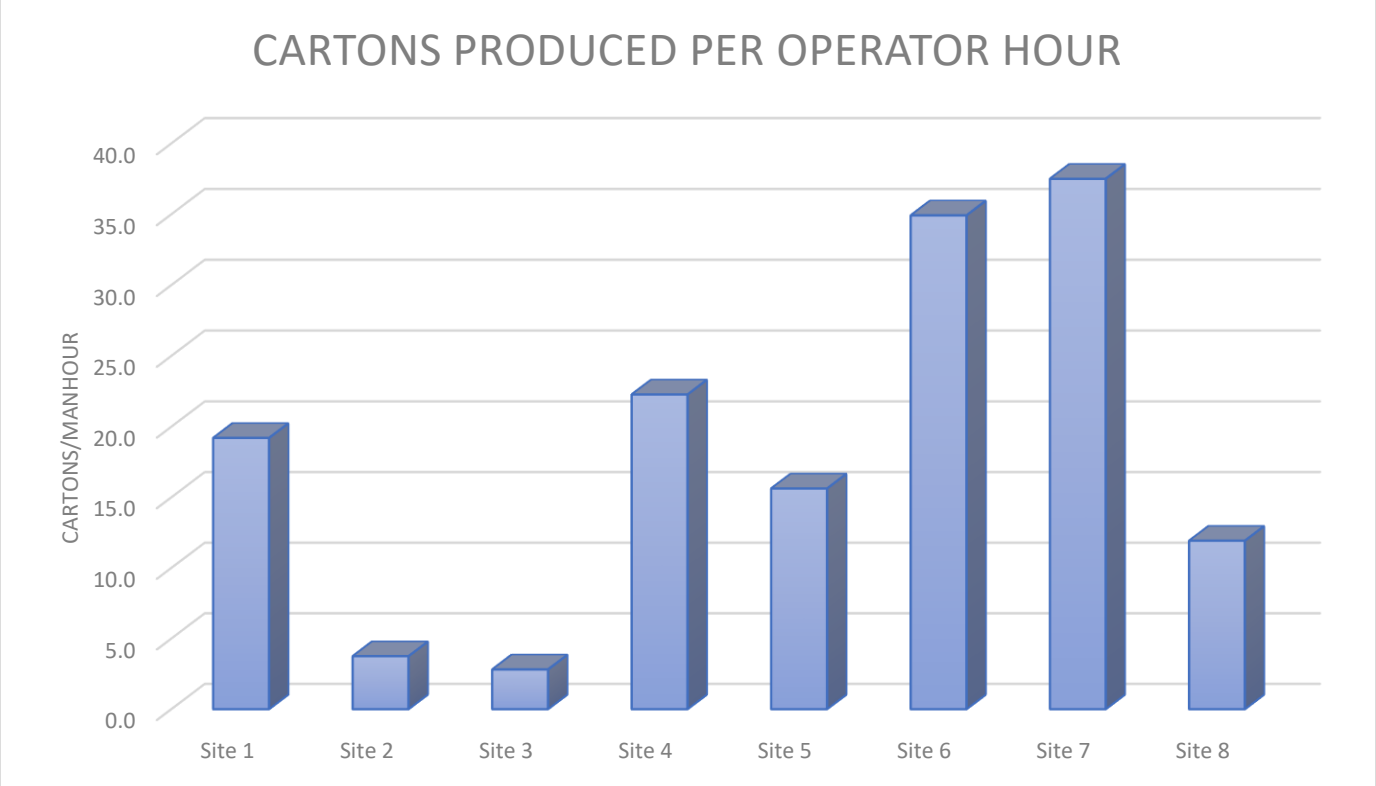


CHART 2 – BENCH LINE LABOUR PERFORMANCE FOR EACH OF THE PARTICIPATING SITES

The most efficient sites were producing over 30 to 40 cartons per operator hour, while others were operating as low as 3-12 cartons per operator hour. While there are some mitigating factors that are not accounted for in the graph, including the number of SKUs, it does however demonstrate the disparity of efficiencies in the sample set.

Key Training and Technology Outcomes

As detailed in the methodology, the latest technologies, options and solutions have been evaluated to help understand how effective they were at resolving the common industry issues. This is shown below in table 1 and chart 3 below.

Issues / Solution	Staff Shortage	Personal Injury	Forklift Interaction	Carton Present-ation	Space Utilisation	Carton Handling Damages	Miscount of Cartons	Energy Usage	Invalid Carton Labels	Organic Stains on Cartons	Slipping Hazards	Unstable Pallet Stacks	Cartons Stuck in Stillages	Defective Pallets	Incorrect Carton Mixes
Healthy Work Culture	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Frontline Leadership Training	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pedestrian & Forklift Segregation	✓	✓	✓	✓	✓	✓					✓			✓	✓
Exoskeleton Suit	✓	✓		✓		✓	✓		✓		✓	✓		✓	
Vacuum Lifters	✓	✓		✓		✓			✓		✓	✓		✓	
Auto Stillage Loader & Unloader	✓	✓	✓		✓	✓					✓				
Auto Storage & Retrieval System	✓	✓	✓	✓	✓	✓	✓		✓		✓				✓
Carton Accumulation System	✓	✓	✓	✓	✓	✓	✓		✓		✓				✓
Palletisation	✓	✓	✓	✓		✓	✓		✓		✓	✓		✓	✓
AGV	✓	✓	✓			✓		✓			✓			✓	
Optimised Racking	✓	✓	✓		✓	✓		✓						✓	
Carton Compactor	✓	✓		✓		✓	✓					✓	✓		
Carton Design Optimisation	✓	✓		✓		✓	✓					✓	✓		
Plate Freezers	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		
Automated Blast Freezers	✓	✓	✓	✓	✓	✓					✓				

TABLE 1 – SCHEDULE OF TRAINING AND TECHNOLOGY SOLUTIONS[3]

[3] Please refer to the Summary of Technology & Options section and appendix 2 for more details

Chart 3 below shows each solutions impact on the common issues faced by the participating sites. The solutions listed at the top of the chart represent the solutions that will have the greatest impact on the overall performance of a site and it is recommended to prioritise these items. For example, if you freeze cartons in blast freezers, upgrading to a plate freezer will have the biggest impact on overcoming the common issues. If you don't freeze cartons, the next best solution for you is a carton accumulation system. Some of the solutions are capital investments that represent value for money, such as AGVs and automated stillage loaders and unloaders, while others such as healthy work culture and leadership training are holistic in nature and can have a small to medium level of impact on many things.[4]

CHART 3 – RECOMMEND TRAINING AND TECHNOLOGY SOLUTIONS[5]

Although carton sorting systems generally have a high capital investment, they have also been identified as one of the more effective options that will help overcome many of the issues small to medium size facilities are experiencing in regard to injuries, staff shortages, property damage, carton and pallet presentation issues, and product rework issues. NIRAS has identified a carton accumulation system which has been adapted from existing technologies overseas in the pork industry. With a lower capital investment than other more automated ASRS systems, it is a cost effective solution for processors sorting more than 4 cartons per min, and provides significant operational saving ($360k+) and simple payback of between 2 to 3.5 years.

If plants decide to continue to manually palletise cartons then it is recommended to look into supplying exoskeleton suits (AKA Wearable Support Systems) or installing a vacuum lifting system. Prices

[4] Please refer to appendix 2 for details on how these have been graded
[5] Please refer to the Summary of Technology & Options section and appendix 2 for more details

for the suits range from $1.2k to $14k depending on the level of mechanical support the sorting and palletising operators require and thus they are a very affordable option.

Similar to carton sorting systems, plate freezers have a high capital investment, however, they also have been identified as another highly beneficial option that will help overcome many issues such as injuries, staff shortages, increasing energy costs, footprint limitation issues, property damage issues, carton and pallet presentation issues, and product rework issues. Plate freezers provide operational efficiency advantages. They can significantly increase efficiency if downtime is occurring, they can reduce operational costs by between $230k to $2m per annum, they can improve carton presentation, improve container load efficiencies by between $100k to $600k p.a. and have a simple payback of between 2-4 years.

Plate freezers are the more superior and more efficient freezing option offering a good payback, but if the decision is to continue with blast freezers, automated stillage loaders and unloaders are a useful technology that will improve safety and reduce labour and operational costs by between $180k to $450k.

Promoting a healthy culture for staff and developing frontline leaders are positive items that all businesses can continue to improve on. It can be very beneficial to provide team members with the right tools and equipment to complete their job efficiently, safely and to a high standard. Many technology options can also support you endeavours to improve the culture on your site as installing the right equipment can provide for a better and safer environment for your employees to work in.

Carton bulging and inadequate carton and pallet presentation is something that can be addressed and the benefits from addressing it far outweigh the later. It starts with correct sizing of the cartons and designing the cartons correctly to be the right dimensions, the right specification in terms of flute size, and contain the right % of recycled material. You may need to review the way you store the cartons, handle the cartons, pack the cartons, and palletise as all these factors can lead to bulging or inadequate protection. If you are experiencing carton bulging issues, a meat compactor (AKA carton compactors before lidding) is also an effective technology that will lead to better packed cartons thus further improving the pallet presentation. Benefits of between $90k to $780k can be achieved by reducing rework, improving handling, reducing safely incidents, reducing product damage and increasing container load efficiency.

	Plate Freezers	Carton Compactor before Lidder	Carton Accumulation Sorting System with automated palletiser	Automated Stillage Loader and Unloader	AGVs	ASRS multi-shuttle with an automated palletiser
Capacity	2 cartons/min	15 cartons/min	5 cartons/min (up to 12 SKUs)	5 cartons/min	1 AGV (90m/min)	10 cartons/min
Simple Payback ROI (yrs)	**2 - 4**	**1 - 2**	**2 – 3.5**	**1 - 2**	**2.5 - 4**	**4 - 5**
Construction Costs	$300k to $500k	N/A	$140k to $300k	N/A	N/A	$500k to $800k
Equipment Costs	$850k to $1.2m	$200k to $300k	$ 1.1m to $1.6m	$320k to $560k	$330k to $520k	$2.2m to $2.9m
Labour Savings	$180k to $450k	$90k to $180k	$360k to $640k	$180k to $450k	$90k to $180k	$540k to $1.1m
Power Savings	$20k to $30k	N/A	N/A	N/A	N/A	N/A
Reduction in offsite storage costs	$30k to $60k	N/A	N/A	N/A	N/A	N/A

TABLE 2 – NOMINAL SIMPLE PAYBACK AND INDICATIVE COSTING FOR TECHNOLOGY SOLUTIONS[6]

[6] Disclaimer: These are budget costs and estimates that in some instances exclude installation and building works. Furthermore, the capacity of your site might be more or less than the costs depicted above. Please refer to each section below for more details

Other solutions that overcome the many issues participants were experiencing and help to further improve efficiency, reduce operational costs, reduce your reliance on labour, improve safety, reduce reworks, reduce product damage and reduce property damage includes, segregation of pedestrians and traffic, and optimisation of racking solutions. Having effective segregation between traffic and pedestrians prevents incidents, creates for a better culture, improves operational efficiency and reduces rework. Commonly poor space allocation can occur due to a business growing without consideration of logistics and workflow. And similar to other improvement options, the benefits from addressing it far outweigh the later.

Similarly, In most of the small to medium size sites, it was observed that finished goods pallets were often double stacked. Not only is this an inefficient way to store pallets (lesser pallets per sqm), but there are safety concerns associated as well due to structural rigidity of the stacks. Selecting more optimised racking such as satellite racking, live pallet storage, mobile racking, to name a few, can reduce the capital cost of new cold store builds, or optimise the storage capacity of existing stores allowing for more storage space and more efficient transportation, sorting picking and marshalling.

Finally, as detailed above in table 2, AGVs are a solution that offers a payback and helps to improve safety, reduce property damage, and improve efficiency. Ideally, after upgrading to a plate freezer and automating carton sorting system with an automated palletisation system, all pallets will be coming out from one location and an AGV is the natural progression and could be implemented at the same time racking is reviewed and optimised.

Lean Manufacturing

The core concept of lean manufacturing is to specify that you want to create a continuous flow without inconsistency (Mura), overburden (Muri) or waste (Muda), this is a streamline process that doesn't overburden your employees, have fluctuations in performance or be crippled by time consuming activities.[7]

This guide provides many training and technology based solutions, many that are being used by processors in the industry that make for a safer, more organised, streamlined and efficient environment for workers. It must be acknowledged that people and culture play a significant part in achieving best practice and, due to staff shortage issues, people and culture should be a recurrent theme of industry at present.

Best practice can be achieved by offering rewards and incentivising employees. Other times best practice requires capital investment and upgrades to make the business more streamline and efficient. In all cases, the objective is to reduce waste activities and improve operational performance.

IMAGE 1 – THE 8 WASTES OF LEAN MANUFACTURING

In lean manufacturing, waste is specified under 8 headings as follows[8]:

- Defects
- Overproduction
- Waiting
- Unused talent
- Transportation
- Inventory
- Motion
- Extra-Processing

Throughout this Guide we detail solutions that can be utilised by all small to medium size processors and how the correct technology selection can reduce the waste activities. In some instances the cost of certain equipment could be too high for certain organisations, hence this guide also provides alternative technology solutions that can be used to simplify the manufacturing processes at a lower capital investment cost.

[7] (Woolfrey, 2020)
[8] (Skhmot, 2017)

Building an environment where employees have a sense of satisfaction is also an essential component of Lean Manufacturing. Improving staff motivation will help raise quality by reducing mistakes, manage difficult people, boost morale and productivity and retain skilled team members.[9] Maslow's hierarchy of needs[10] gives a visual representation of the different levels of needs which will inspire motivation from your team.

- Access to essentials
- Financial security, health & wellness and safety against accidents or injury
- Sense of belonging and acceptance
- Appreciation and respect
- Self-actualisation

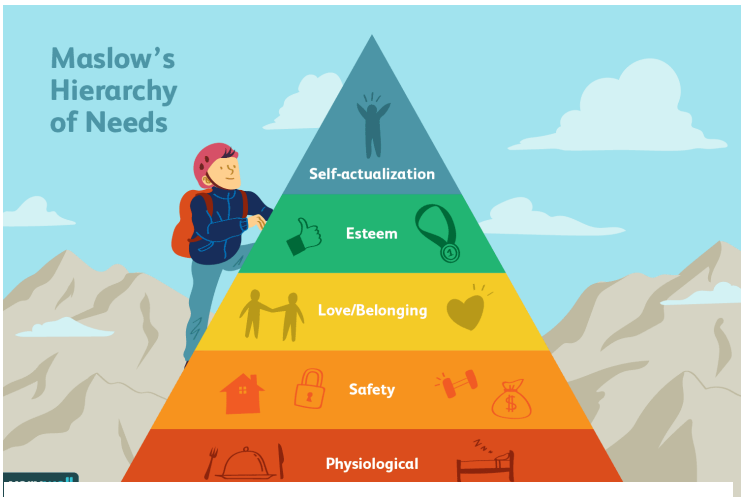


IMAGE 2 – MARLOW'S HIERARCHY OF NEEDS

[9] (Maurer, 2012)
[10] (Cherry, 2022)

How to use “The Best Practice Guide”

Each technology and option detailed in “The Best Practice Guide” has been evaluated against each of the common themes and present issues. Table 1 detailed in the “Technology and Options Analysis” above can be used to identify the training and technology solutions that are suitable for your business depending on themes or issues. Contained in Chart 3 (recommended training and technology solutions) above also gives each solution a grading in regards to how effective each solution is at addressing the current common issues the industry has highlighted. This is to be used as a useful tool to help prioritise the solutions detailed in this guidebook. Finally, a summary and further details of each technology and option can then be found in the “Summary of Technologies & Options” section of the best practice guide below.

Capital Cost Rating

Capital costs have been graded on a scale as follows:

Low : < $99k
Medium : $100k to $749k
High : $750 to $1.99 Million
Very High : $2 Million +

Safety Hierarchy of Control

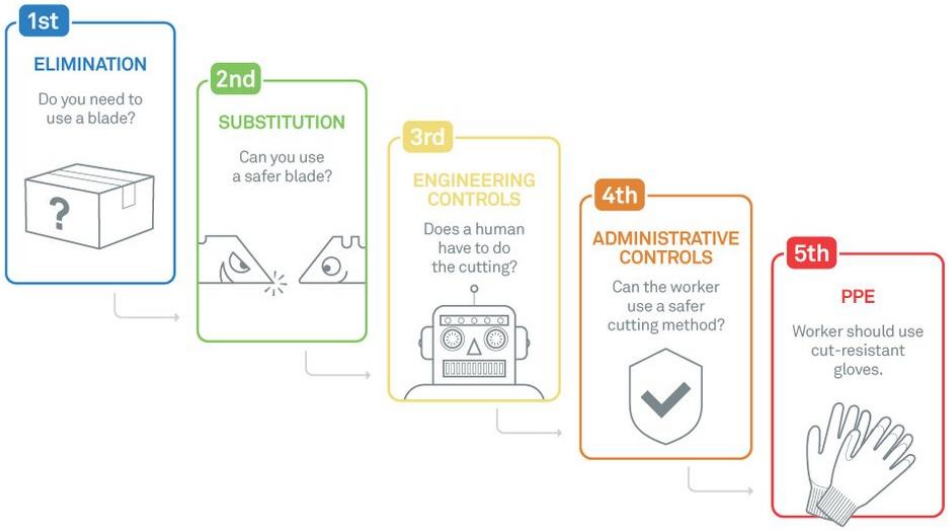


IMAGE 3 – HIERARCHY OF CONTROL [11]

The safety hierarchy helps processors and organisations understand what level of control is being utilised to prevent an injury. This is specified in the summary of each option detailed in this guide. It’s important to choose the right level of control for the intended safety or quality risk .[12]

[11] (Products, 2020)
[12] Please refer to Appendix 3 for further information provided by WorkSafe Victoria. Similar information can be found by contacting your local state WorkSafe body as the state that you are in may have different regulations.

Summary of Technologies & Options

Exoskeleton Suit

Cost : Very Low ($1.2k – $12k each suit) and expect less safety issues
Safety Hierarchy of Control : PPE (5)
Operational Improvements : Operators will be less fatigued, productivity will increase, operators will be more aware of issues and less likely to injure themselves.

What is the issue at hand?

Repetitive strain injuries and lower back injuries were common issues highlighted by the industry and there are evidently a number of issues when injuries occur. As it is common for operators in the carton handling and storage area of small to medium size meat processing facilities to have to lift and carry cartons, sometimes weighing up to 27kg, the likelihood of them accidentally injuring themselves is also increased. There are many automated solutions that have potential good payback periods for all manual handling activities in the carton handling and load out areas contained in this report, however, when manual handling is still required, it is recommended to provide wearable support system (AKA exoskeleton suite.)

What is an Exoskeleton Suit?

An exoskeleton suit is a device used to assist employees when manual handling is required to load/unload stillages, palletise cartons or rework pallets. The suit can be worn over the top of the cold store pants and under cold store jackets.[13] Some suppliers also have suits that can be worn by employees jumping on and off forklifts.[14] These suits are designed simplistically and without any power requirement, making them a completely passive and affordable option that can lower muscle activity at fatigue and injury prone areas.[15]

IMAGE 5 – OTTOBOCK EXOSKELETON SUIT

One of the sites involved in the project was already utilising an exoskeleton suits with much success. Although the reference site does not mandate the use of it, it was encouraged to be used for new operators that are not accustomed to lifting heavy objects and/or lack the strength to carry out their tasks. These operators were also given the choice to continue or stop the use of the suits when they had built up the strength required to complete the tasks effectively without injuring themselves.

[13] (Ottobock, 2022)
[14] (SuitX, 2021)
[15] (Auxivo, 2022)

What current technology does it replace?

This is a low cost option that can be used if other automated solutions detailed with this handbook such as automated stillage loaders/unloaders, low-cost carton sorting and palletising systems and vacuum lifters for carton sorting cannot be implemented. When manual handling and lifting is necessary and operators are not proficient with correct manual handling and lifting procedures, then an exoskeleton suit can be offered as a tool in building necessary muscles, or to assist them on an ongoing basis.

Why is it better? Who would benefit from it?

This is a proactive way of supporting and empowering your employees who are required to complete manual handling and lifting tasks. The exoskeleton suits will support them in critical, injury prone areas of their lower back and reduce fatigue while they are building up muscles and learning correct lifting techniques. Though we have focused on finding suppliers of suits for lifting and manual handling of cartons, there are also many other exoskeleton options to prevent a range of other repetitive strain injuries.

What are the limitations and challenges?

On the hierarchy of safety controls, this option is on the lower end in comparison to other options.[16] Engineering controls such as carton sorting and palletising systems, vacuum lifters for carton sorting or automated stillage loaders/unloaders are favourable options for addressing the lifting and repetitive strain injuries. If these engineering controls cannot be implemented, wearable support systems or exoskeleton suits are a very effective low cost solution.

This is a new and growing industry and there are many options available, with new, more user friendly options coming out regularly. It is important to do some research and find out which supplier is right for you and which option suit is best for the tasks being completed.

IMAGE 6 – AUXIVO WEARABLE SUPPORT SYSTEMS

Where can I find this technology?

There are many local exoskeleton suit providers that have representative that provide a trial period and training support. In some cases the reps can come to your site to complete the training, otherwise, they have also had a lot of success completing the training over a number of teams meetings during the trial period thus also helping to reduce the associated costs.

Please ensure you discuss this with NIRAS Australia or your AMPC Co-Innovation manager for the latest most relevant providers that can assist you with all options contained in this report. In some cases, funding may be available for the adoption of your improvement project so please also discuss this with your AMPC representative.

NIRAS Australia can be contacted on: **E: glja@niras.com**

[16] Please refer to appendix 3

The most up to date list of the current AMPC team members can be found at “Our Team” on the AMPC website - https://www.ampc.com.au/about-us/our-team

Alternatively, some suppliers to reach out to are as follows:

- SpanSet Australia - Auxivo suit suppliers - https://www.spanset.com/au
- Paexo - supply both the Ottobock and SuitX suits - https://paexo.com/

Useful links and reference material

ExR Exoskeleton Report (Latest news and updates) - https://exoskeletonreport.com/

Carton Compactor before Lidding

Capital Cost : Medium ($100k - $300k) and expect a good payback
Safety Hierarchy of Control : Engineering Control (3)
Operational Improvements : Less rework, better carton/pallet presentation, better container load efficiency, and better carton/pallet stability thus reducing falling issues when double stacking.

What is the issue at hand?

Sites have reported that their cartons are prone to bulging and expansion during the freezing process causing instability on palletised products and some cartons to fall off pallets when palletising. This may result in damaged goods and potential safety hazards, such as cartons falling off onto operators, operators picking up cartons that have fallen off on slippery surfaces, etc. The unit provides for safer packing, reduces the risk of cartons falling from pallets, reduces rework and can help contribute to increased container load by up to 9% due to reducing product bulging during the freezing process.[17] A couple of sites we spoke to had resolved their carton bulging issues and were able to fit 12 layers into a 20 foot container as opposed to 11 layers prior to compacting.

What is a Carton Compactor?

A carton compactor is a device that expels the air and settles product in cartons as part of a meat packing line.[18] This technology can and should be used to complement good carton packing controls in the Boning room. A carton compactor is to be installed before the carton is lidded for any meat product that is being bulk packed in cartons.

IMAGE 7 –BOX COMPACTOR

What current technology does it replace?

This technology does not replace any of the existing protocols or technologies, rather it complements your existing carton packing protocols, improves carton/pallet presentation, reduces the risk or carton falling from pallets and reduce the risk of cartons getting stuck in stillages during the blast freezing process.

Why is it better? Who would benefit from it?

The system allows the carton closing or lid placement to be level with the top of the carton, for best strapping, freezing, stacking and appearance of bulk packed products. The unit provides for safer packing, reduces the risk of cartons falling from pallets, reduces rework and can increase container load by up to 9% as detailed above.

[17] (Automation, 2022)
[18] (SES, 2022)

Some sites had 1 to 4 operators working full-time to rework pallets that had fallen and required restacking. Other sites had operators who had to strategically stack cartons on pallets to prevent the pallets from falling over when they transported them. If this is the case for your site then a carton compactor offers a good payback as detailed below. You may also experience cartons getting stuck in stillages or work place incidents when sorting and palletising cartons. If this is the case, then a carton compactor combined with effective carton design and good packing practices (detailed below) could be a viable solution.

IMAGE 8 – BULGING CARTONS

Unit Capacity	15 cartons/min
Simple Payback	1 to 2 years
Equipment Costs	$200k to $300k
Labour Savings (less labour cost due to less rework and more efficient palletising)*	$90k to $180k
Footprint	3.5m x 1.4m

* Labour savings are based off $90k per person. Savings exclude safety cost saving, property damage and product damage savings.

* This excludes container load saving which could be an additional $100k to $600k per year.

What are the limitations and challenges?

To incorporate these into your facility you will need space between your carton lidding station and your boning room.

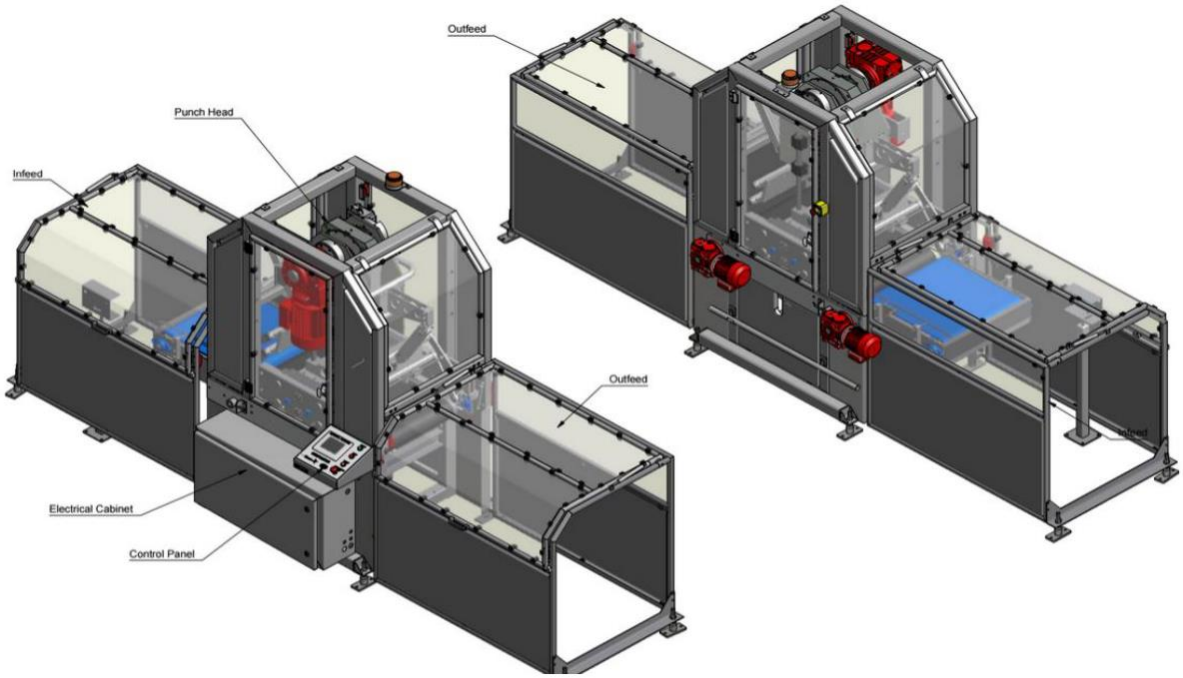


IMAGE 9 – BOX COMPACTOR

Where can I find this technology?

Currently, carton compactors are not commonly used in small to medium processors, but the technology is being applied in a few processors and have provided great results. There are local suppliers and several international suppliers for this technology.

Please also ensure you discuss this with NIRAS Australia or your AMPC Co-Innovation manager for the latest most relevant providers that can assist you with all options contained in this report. In some cases, funding may be available for the adoption of your improvement project so please also discuss this with your AMPC representative.

NIRAS Australia can be contacted on: **E: glja@niras.com**

The most up to date list of the current AMPC team members can be found at “Our Team” on the AMPC website - https://www.ampc.com.au/about-us/our-team

Alternatively, some suppliers of meat compactor are as follows:

- Southern Engineering Solutions - https://sesltd.co.nz/
- MHM Automation - https://mhmautomation.com/

Useful links and reference material

N/A

Carton Design Optimisation

Cost : Low – Allocate a resource or consultant to design and specify the optimum carton requirements
Safety Hierarchy of Control : Substitution (2)
Operational Improvements : Less rework, better carton/pallet presentation, better carton/pallet stability reducing safety risks, and better container load efficiency.

IMAGE 10 – INEFFICIENT CARTON DESIGN

What is the issue at hand?

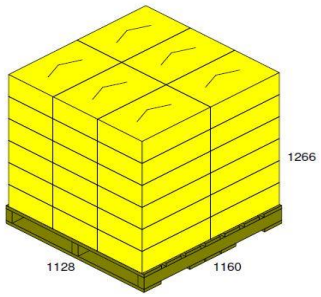
Carton design is a crucial factor as it can severely affect the process post-carton packing. Details like carton dimensions, flute size, cardboard quality, interlocked stacking pattern, pallet overhang, storage methods and the amount of recycled materials can all have an impact on the product presentation and rigidity. Some carton packers were observed to be struggling with fitting products into cartons which can then have an effect on pallet stability, cartons falling off pallets, carton presentation and container load efficiency. Incorrect carton design may become an issue when introducing automated machinery down the line due to requirements for uniform cartons. Finally, processors must ensure that they meet the Australian Standard for fibreboard boxes for the export of meat, meat products and offal.

What is Carton Design Optimisation?

Carton Design Optimisation is the process of reviewing the current requirement and practices to ensure that cartons are sized, specified and being supplied to meet your organisations requirements. This process looks at all aspects of the product manufacturing, supplier and distribution life cycle to ensure cartons achieve the intended fit for purpose results.

When choosing the right flute/board type the following must be considered:

- Storage of boards,
- Product weight and type of product being used,
- Packing type, chilled, hot boned, etc,
- Lid and full base with strap or lid and glued base automatically applied



CHEP Pallet 1165x1165x150

	Shipper (ID)	Shipper (OD)	Shipper Bulge	UnitLoad (Incl. Pal)
Ln:	580 mm	580 mm	0 mm	1160 mm
Wd:	376 mm	376 mm	0 mm	1128 mm
Ht:	186 mm	186 mm	0 mm	1266 mm
Net:		0.0 kg		0.0 kg
Grs:		0.0 kg		43.0 kg
Cube:	41 l	41 l		1657 l
		Height Vert		
Shipper:				36
Area Efficiency:		0.00 %		96.41 %
Cubic Efficiency:		0.00 %		93.56 %
Cases per layer:				6
Layers/load:				6
Pattern:				Column
Density (gr/cc):				0.0000

IMAGE 11 – CARTON DESIGN PALLET LAYER PATTERN

Several observations were made on site and while viewing and talking about carton presentation. Some processors were having issues with cartons bulging, cartons falling off pallets or cartons not withstanding supply chain handling of customers products. Some cartons were either overpacked or unable to support the structure of chilled products in storage. All carton suppliers can assist in the development of optimum product packing and palletising efficiencies. It is also

important to talk to them about the GSM (grams per square meter) of the paper and the recycled content percentage as both of these have an impact on board quality.

What does good carton design replace?

The Carton Design Optimisation doesn't replace any technology, but it ensures the optimum design and fitness for purpose of each carton. This solution doesn't replace the need for improved packing methodology in the packing process, but ensures that the cartons offer a suitable secondary packaging method that enhances the ability to store and distribute product without damage and safety concerns.

Why is it better? Who would benefit from it?

Correct carton design will improve carton presentation, reduce errors, reduce rework, prevent cartons from falling from pallets, prevent pallets from falling when double stacked, and prevent cartons from being stuck in stillages during the blast freezing process. Good design can also significantly increase your container load efficiency resulting in more cartons being able to be loaded into containers and savings of between $100k to $600k p.a. for a small to medium size processor. When they reduce the total number of containers being sent each year.

All small to medium processors will benefit from carton design optimisation, as this process helps to reduce several of the identified issues.

What are the limitations and challenges?

Carton Design Optimisation still requires the effective management of carton packing techniques and handling, as poor manufacturing practices cannot be overcome with just the correct carton design. Furthermore, effective controls will need to be in place to ensure the correct products are still packed in the suitable cartons, and like other described technologies, effective training and understanding by operators is paramount.

Where can I find out more?

All carton suppliers offer the service of design optimisation. Each supplier will have inhouse design specialists that can audit and assess design and board grade capacities

Please also ensure you discuss this with NIRAS Australia or your AMPC Co-Innovation manager to assist with improving your process. In some cases, funding may be available for the adoption of your improvement project so please also discuss this with your AMPC representative.

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Useful links and reference material

AS 3724—1994 Fibreboard boxes for the export of meat, meat products and offal.

Plate Freezers

Capital Cost : High / Very High ($800k to $5m depending on capacity) but expect a payback as detailed below.
Safety Hierarchy of Control : Elimination (1) & Engineering (3)
Operational Improvements : Reduce forklift interactions, reduce manual handling, reduce labour requirements, reduce energy costs, reduce property damage, reduce product rework issues, makes for more available factory space, improves container load efficiency, and improve carton/pallet presentation issues .

What is the issue at hand?

Most small to medium size sites use blast freezers as the main method for freezing carton products. Using blast freezers is a labour intensive process. It requires several operators at a time to load and unload cartons in stillages and transport them to and from blast freezers. Blast freezers are also an inefficient freezing process. They rely of convection heat transfer from air to the product, resulting in it needing to cool the entire room, alongside with occasional air spills due to frequent traffic between rooms. This leads to longer freezing time, frost issues, and higher operating costs.

What is a Plate Freezer?

Plate freezers of all sizes and styles are a highly efficient way of freezing products. They are built in insulated rooms and have large banks of horizontal freezing plates positioned within a steel frame. Liquid ammonia (or liquid CO2[19]) circulates through the movable plates, enabling them to rapidly and efficiently cool cartons of meat by transferring heat by conduction from the product to the evaporator.[20]

IMAGE 12 – PLATE FREEZER

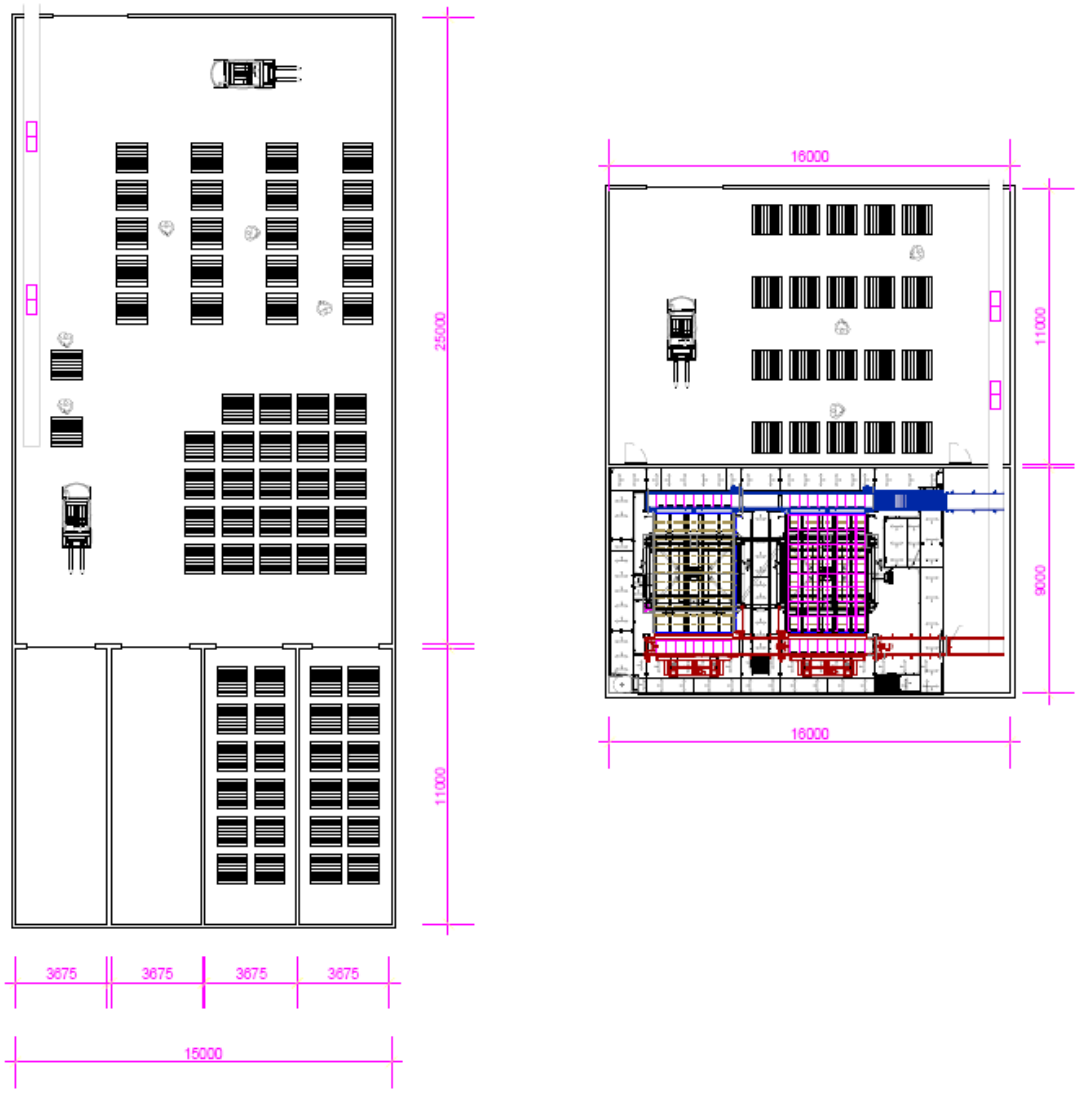
What current technology does it replace?

Plate freezers replace the need for loading stillages, transporting stillages and inefficient blast freezers. Instead of having to complete these timely and inefficient tasks, the product goes into the plate freezer and out the other end frozen in either a fully or semi-automated process.

[19] (Brothers, 2018)
[20] (Condon, 2017)

BLAST FREEZING
TOTAL FLOOR AREA
540m2

PLATE FREEZING
TOTAL FLOOR AREA
320m2



DRAWING 1 – COMPARISON OF FACTORY SPACE REQUIRED FOR 2 X 760 CARTON CAPACITY PLATE FREEZERS VS 4 X 760 BLAST FREEZERS

Why is it better? Who would benefit from it?

Unlike blast freezers that require a significant amount of space for stillages, forklift traffic, people loading and unloading stillages, and the blast freezers themselves, plate freezers take up much less space and remove the need for much of the manual handling and transportation required by blast freezers.

Plate freezers are very efficient due to the plates making contact with the top and bottom of the carton thus drawing the heat via conduction directly from the product contained in the carton. This reduces the risk of product quality issues and reduces the time it takes to freeze the product. Typically freezing is completed in 16-24hrs rather than 40-48 hrs. Most importantly, the power required to freeze a tonne of

product is significantly reduced. In round numbers, a typical plate freezer will use about 30% less energy than conventional blast tunnels due to not having to run fans and having a more efficient heat transfer. [21] This equates to a saving of at least $21k p.a. for a site running 1x 760 carton plate freezer instead of 2x 760 blast freezers.

Plate freezers reduce your labour requirements and forklift movement requirements. This can be anywhere from 2 to 13 people for a small to medium size site and equates to savings between $180k to $1.2m p.a. Reducing the number of forklifts required to load and unload the blast freezers can also reduce operational costs. Furthermore, the risk of manual handling injuries, product damage issues, property damage issues (from forklifting activities) and personnel slipping hazards is all reduced or eliminated which small to medium business were seen to be paying between $15k to $200k p.a.

Sites who are using off site storage you can also reduce this cost by gaining some of this storage space back by anywhere between 120m2 to 700m2 depending on the sites current operation.

Finally, plate freezers help to prevent product bulging during the freezing process so upgrading to plate freezers can also reduce handling issues down the line and improve container load efficiency as well. Sites that had addressed their carton bulging issues were able to increase container load efficiency by up to 9%, this equates to a 12th layer in a 20 foot container and savings of between $100k to $600k p.a. in shipping costs.

Rate/Capacity	760 cartons/day	3,000 cartons/day
Simple Payback	2.5 to 4 years	2 to 3.5 years
Construction Costs	$300k to $500k	$900k to $1.5m
Equipment Costs	$850k to $1.2m	$3.2m to $4m
Labour Savings*	$180k to $450k	$0.8m to $1.2m
Power Savings*	$20k to $30k	$80k to $120k
Reduction in offsite storage costs due to gaining more storage space	$30k to $60k	$110k to $240k
Footprint	8m x 9m	30 x 9m

* Labour savings are based off $90k per person. Savings exclude safety cost saving, property damage and product damage savings.

* Power savings are calculated off $0.06 per kWh

* Off site storage was calculated assuming 4 weeks of storage and a cost of $7 per carton.

* This excludes container load saving which could be an additional $100k to $600k per year.

What are the limitations and challenges?

Plate freezers can have a greater capital cost compared with conventional air blast freezers.

Plate freezers require a large refrigerant charge and if ammonia is selected there are regulatory requirements due to it being a dangerous goods. There are health and safety concerns when using certain refrigerants at high quantities and you must follow all regulatory requirements in regards to this.

Plate freezers need to be designed to suit the application. Carton and product mix must be considered in the design.

[21] (Graham, 1996)

Where can I find out more?

Plate freezers are increasingly becoming more feasible and technologically advanced. They are available commercially and can be sourced locally within Australia, and like most equipment suppliers, they have representatives that can come to your site to assist with developing a working solution.

Please also ensure you discuss this with NIRAS Australia or your AMPC Co-Innovation manager to assist with improving your process. In some cases, funding may be available for the adoption of your improvement project so please also discuss this with your AMPC representative.

The most up to date list of the current AMPC team members can be found at “Our Team” on the AMPC website - https://www.ampc.com.au/about-us/our-team

NIRAS Australia can be contacted on: **E: glja@niras.com**

Alternatively, some suppliers that specialise in the delivery of plate freezer solutions include:

- Hoctors Refrigeration - https://hoctorrefrigeration.com/services/
- MHM Automation (Milmeq) - https://mhmautomation.com/
- Gordan Brothers - https://www.gordonbrothers.com.au/

Useful links and reference material

(Graham, 1996)

(Hessami, 2004)

Automated Blast Freezers

Capital Cost : High / Very High
Safety Hierarchy of Control : Engineering (3)
Operational Improvements : Improves operational efficiencies, reduce manual handling requirements, reduce labour requirements, reduce forklift requirement, reduce forklift interactions, consolidate like processes and reduce property damage from forklifts.

What is the issue at hand?

Conventional blast freezers used by most small to medium size sites are manually handled by several operators to freeze products, which involve loading and unloading cartons in stillages and transport them to and from blast freezers. This requires high labour costs in addition to the difficulty in sourcing labour in the current climate. As blast freezers normally require the cooling of entire rooms, traffic between rooms would cause occasional air spills, resulting in longer freezing time, frost issues, and higher operating costs.

What are Automated Blast Freezers?

Automated blast freezers still use the conventional blast freezing method. The difference is the automation of product handling by feeding the blast freezers using sets of conveyor systems. There are a few ways that this can be achieved:

Stillage handling – Putting the stillages on conveyors to be fed and frozen in the blast freezers for 48 hours before the conveyors take the stillages out for palletisation.

Carton handling – Putting carton products on conveyors similarly, however due to the size of cartons, the conveyor systems can be stacked like “shelves” for better space utilisation. Visually, the system would logistically look similar to the plate freezers but the freezing methodology is different.

IMAGE 13 – AUTOMATED BLAST FREEZER

What current technology does it replace?

The technology improves on traditional blast freezing system in the logistical sense as it automates product handling rather than transporting them manually. Depending on the intended scale of the operation, existing blast freezers may be reused or rescaled.

Why is it better? Who would benefit from it?

Although you don’t get all the added benefits from plate freezers, you will get some added benefits. Automated blast freezers will reduce labour requirements and will eliminate the need to manually transport products in and out of blast freezers. This reduces workload for operators reducing your labour cost by between 2 to 12 + people depending on the capacity required. The risk of injuries from slipping and manual

handling activities is also reduced. Similar to plate freezers, you will also get benefits from reducing the number of forklifts required to load and unload the blast freezers .

Capacity	3,000 cartons per day
Simple Payback for a machine running at 3,000 cartons per day	3 to 4 years
Construction Costs	$650k to $1m
Equipment Costs	$3.0m to $3.8m
Labour Savings*	$0.8m to $1.4m
Footprint	32m x 10m

* Labour savings are based off $90k per person. Savings exclude safety cost saving, property damage and product damage savings.

What are the limitations and challenges?

The freezing efficiency is much less than plate freezers and you wont get the added benefit of reducing product bulging during the freezing process which can result in container load efficiency improvements of between $100k - $600k p.a.

Capital cost to implement the technology, specifically due to the carton handling methods, can be intensive depending on the level of automation and number of cartons to handle. When considering the capital cost vs freezing efficiency, comparisons should be drawn out between automated blast freezers and plate freezers to assess which options would be more appropriate.

Where can I find out more?

The technology is commercially available locally and have been implemented in several plants for both within and outside of the red meat industry. Local refrigeration providers can offer to install the automated blast freezing system. For better optimisation and confidence, please discuss this with NIRAS Australia or your AMPC Co-Innovation managers.

NIRAS Australia can be contacted on: **E: glja@niras.com**

The most up to date list of the current AMPC team members can be found at “Our Team” on the AMPC website - https://www.ampc.com.au/about-us/our-team

Alternatively, some suppliers that specialise in the delivery of these systems include:

- MHM Automation (Milmeq) - https://mhmautomation.com/
- Hoctors Refrigeration - https://hoctorrefrigeration.com/services/

Useful links and reference material

N/A

Vacuum Lifters for Carton Sorting and Palletising

Capital Cost : Low / Medium ($20k to $300k)
Safety Hierarchy of Control : Engineering (3)
Operational Improvements : Reduce manual handling requirements, improve operator efficiency, improve carton/pallet presentation issues and reduce product rework issues.

What is the Issue at hand?

A vacuum lifter is a useful solution for helping to reduce manual handling incidents when sorting cartons, manually palletising or manually reworking pallets. In some instances an automatic palletiser is not an effective solution and a vacuum lifter could be a more effective option.

What does a Vacuum Lifter do?

Vacuum lifters can be utilised to assist operators in lifting heavy products. The vacuum lifters will be stationed within palletising areas where operators can manually handle the device to palletise the cartons. The vacuum lifters are mechanically supported to relieve the carrying load from operators. Cartons are gripped through the vacuum grippers of the lifters. The technology is being used commercially and is readily available. They are built to the side or over the top of existing carton sorting and palletising areas, thus they only take up space above the existing carton sorting and palletising areas.

IMAGE 14 – MANUALLY OPERATED VACUUM LIFTER

What current technology does it replace?

Vacuum lifters are a low to medium capital cost option that complement the manual carton sorting and handling process used by many small-medium size facilities. Vacuum lifters are an alternative solution to the exoskeleton suit and the automated carton sorting and palletising system

Why is it better? Who would benefit from it?

Similarly to the exoskeleton suit, operators employed in the manual handling space, particularly in carton sorting and palletising, can benefit from the mechanical support of the technology by substantially reducing the load off the operators, reducing fatigue and chances of lower back injuries. The technology won't necessarily reduce labour requirements but they will make for a better work environment for your employees and reduce injury risk and consequence.

What are the limitations and challenges?

Vacuum grippers require gantries or cantilever support and this must be able to be integrated into the existing building or built over the top of the existing area. If multiple stations are to be implemented, they can be quite prohibitive for working areas depending on its scale and build.

Repetitive strain injuries are still a risk due to operators having to manually activate the vacuum and move the vacuum head to the required pallet location. Moreover, safety precautions are necessary to ensure that pedestrians and forklifts do not accidentally intrude within the vicinity of the vacuum grippers.

Where can I find out more?

Vacuum grippers/lifters are available commercially and can be found in many commercial settings. They can be sourced locally within Australia, and like most equipment, have representatives that can perform demonstrations.

Please also ensure you discuss this with NIRAS Australia or your AMPC Co-Innovation manager to assist with vacuum lifter scoping and selection. In some cases, funding may be available for the adoption of your improvement project so please also discuss this with your AMPC representative.

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Alternatively, some suppliers that specialise in the delivery of these systems include:

- PT System & Automation - https://www.ptchronos.com/en-oce
- B & B Industrial - https://bbindustrial.com.au/bulk-material-handling-solutions

Useful links and reference material

N/A

Optimised Racking Solutions

Capital Cost : Medium / High ($150k to $2m)
Safety Hierarchy of Control : Engineering (3)
Operational Improvements : Reduce forklift movements, reduce forklift interactions, improve safety, make for move available factory space, improve operator efficiency, reduce product rework issues and can reduce labour requirements.

What is the issue at hand?

In most of the small to medium size sites, it was observed that finished goods pallets are often double stacked. Not only is this an inefficient way to store pallets (lesser pallets per sqm), but there are safety concerns associated as well due to structural rigidity of the stacks.

What are some Optimised Racking Solutions?

There are several ways to optimise the racking configuration of a warehouse, from revising layouts to promote better workflow to using alternative racking types.

Many warehouses conventionally use selective racking by default without putting in much considerations of the available options. These variants can be something simple and static or more autonomous and mechanically involved. Some of these examples are:

Double Deep Racking - Essentially similar to selective racking but double in depth. Requires reach forklift to operate.

Drive-In Racking - Racking where aisles can be accessed with a forklift. May require different forklift builds to fit through the aisles.

Satellite Racking - Similar racking setup as a drive-in racking, but with the use of a shuttle robot to transport pallets rather than driving in with a forklift.

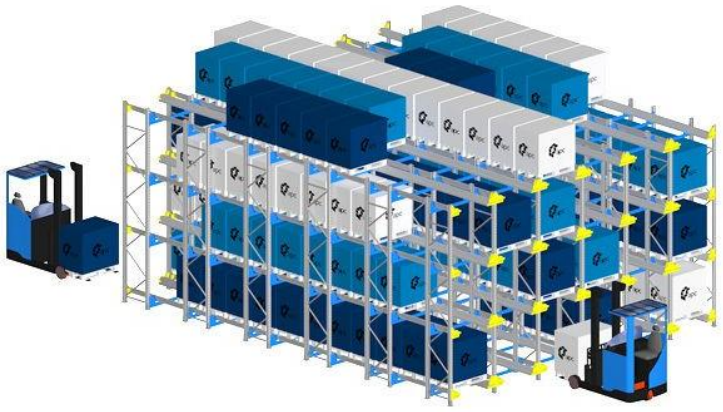

IMAGE 15 – HIGH DENSITY SATELLITE PALLET RACKING

Mobile Racking - Each set of racking are built with wheels that sit on rails, allowing the racking to be moved in a specific axis to create spaces for aisles and further compacts the racking.

2D Shuttle - A high density storage and retrieval option that runs products along aisles via a shuttle to the correct storage location and back to the retrieval location when required.

What current technology does it replace?

This solution improves on ineffective racking layouts with transversal and logistical issues. If alternative racking types are considered, it would normally replace existing racking in sites, which are typically selective racking.

Why is it better? Who would benefit from it?

If layout revamps are taken into consideration, it would benefit operators with easier inventory management and warehouse transversal. Sites can reduce labour by between 2 - 4 people by improving the process flow and reducing the amount of sorting, double/triple handling, and marshalling they are doing.

Capacity of Satellite Racking	416 pallets
Simple Payback	4 to 5 years
Construction/Building Costs*	$0.9m to $1.6m
Equipment Costs	$230 to $360
Labour Savings*	$180k to $360k
*Footprint	25.7m x 12.0m

* Labour savings are based off $90k per person. Savings exclude safety cost saving, property damage and product damage savings.

*Allowed for space for tolerances and forklift traffic

What are the limitations and challenges?

When re-designing warehouse racking layouts, it is important to keep in mind factors that contributed to the complications of the former layouts and its subtleties, such as ease of accesses to other rooms, well-structured, non-irregular racking layouts, and working culture in the warehouse.

With an array of choices, it can be challenging to pick the right racking, especially if one is not familiar with any of them. Each choice come with their own pros and cons. What works for a site does not necessarily translate the same for others.

Where can I find out more?

Layout optimisations can be achieved with the support of process consultants with warehouse logistics experience.

Alternative racking is commercially available locally. There are suppliers that source equipment overseas, especially options with some level of automation, and others that are OEM. Many of these options have been built on various sites and have provided satisfactory results.

Please also ensure you discuss this with NIRAS Australia or your AMPC Co-Innovation manager to assist with racking optimisation. In some cases, funding may be available for the adoption of your improvement project so please also discuss this with your AMPC representative.

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Alternatively, some suppliers that specialise in the delivery of these systems include:

- STOW Group - https://www.stow-group.com/en-AU
- Dematic - https://www.dematic.com/en-au/
- Dexion - https://www.dexion.com.au/
- Schaefer - https://www.ssi-schaefer.com/en-au

Useful links and reference material

For a list of the different racking options please visit [22] – https://www.logisticsbureau.com/spotlight-on-the-10-most-common-pallet-racking-systems/

[22] Disclaimer: Costings provided are representative and some options may work out to be more expensive or cheaper than the others. Consult Niras Australia to assist with choosing the right options.

Automated Stillage Loader and Unloader

Capital Cost : Medium ($120k – $300k)
Safety Hierarchy of Control : Engineering (3)
Operational Improvements : Reduce manual handling requirements, improves safety, reduces labour requirements, reduce forklift interactions and can reduce product rework.

What is the issue at hand?

Handling cartons to and from stillages can be labour intensive and repetitive, and comes with its own associated issues, such as cartons getting stuck, unergonomic carton handling, and potential personnel injuries.

What is a Stillage Loader/Unloader?

Currently, cartons are stacked on stillages manually for freezing processes. Automatic stillage loaders and unloaders can eliminate the manual process by incorporating a conveyor lift and a pushing mechanism to load and unload cartons into and from stillage slots. The equipment involved are relatively compact and can be incorporated in small to medium size plants.

IMAGE 16 – STILLAGE UNLOADER

What current technology does it replace?

The technology does not replace any technology, but alleviates manual handling of cartons. This is a suitable option for businesses that choose not to upgrade or implement plate freezers and use blast freezers instead.

Why is it better? Who would benefit from it?

This is an excellent engineering solution for small to medium size facilities that want to improve occupational health & safety issues that come with manually loading and unloading stillages and overcome labour resourcing issues. When loading stillages manually, the position of some stillage slots can be challenging for operators as they have to lift and lower, push and pull cartons that can weigh up to 27kgs, especially for unconventional reaches. Implementing the solution would eliminate the required labour to stack and unstack cartons in stillages, and as a result, reducing OH&S risks. Automation of this process will also reduce the chances of damaging the cartons that would happen as a result of poor manual handling.

You can expect a reduction in product damage and safety incidents which can add up and also expect a reduction in labour requirements of between 2 - 5 people due to reducing handling requirements.

Unit capacity	5 cartons per min
Simple Payback	1 – 2.5 years
Equipment Costs	$320k to $560k
Labour Savings*	$180k to $450k
Footprint	4m x 1.8m

* Labour savings are based off $90k per person. Savings exclude safety cost saving, property damage and product damage savings.

What are the limitations and challenges?

The system would require space for the systems to be installed. This would be similar to the space allocated for loading the stillages manually. Generally, their sizes are fairly compact, taking up approximately the width of 1.5 to 2 stillages for each side. Each stillage loader and unloader will have a capped operational rate, partly in due to the time taken for conveyor lifts to move and pushing mechanism to push the cartons in and out of place. Small to medium sites should generally require only 1-2 loaders and 1 unloader unless future plans call for ambitious figures.

Unlike plate freezers, forklift movements in and out of blast freezers are still required to load and unload the freezer and deliver the stillages to and from the loader/unloader. There may be issues with production downtime if forklift drivers aren't vigilant with removing full stillages and replacing them empty ones and you also may still have property damage issues as is with all activities that require a forklift.

Where can I find out more?

Currently, stillage loaders and unloaders are uncommon, but the technology does exist in a few commercial settings and have been effective at overcoming soft tissue and repetitive strain injuries. There are a couple of local suppliers and several international suppliers for this technology.

Please discuss this with your local AMPC Co- Innovation Manager as this technology is new and developing and more suitable options for your operation might now be available. In some cases, funding may also be available for the adoption of your improvement project so please also discuss this with your AMPC representative.

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Alternatively, some suppliers that specialise in the delivery of these systems include:

- Southern Engineering Solutions - https://sesltd.co.nz/

Useful links and reference material

N/A

Frontline Leadership Training for Supervisors

Cost : Low ($5k - $60k per person) and can increase productivity
Safety Hierarchy of Control : Administration (4)
Operational Improvements : Better employee retention, better operational efficiencies, better safety awareness, better quality awareness, better employee engagement, better employee performance, better employee satisfaction, and better organisational success.

What is the issue at hand?

During the site studies, a common theme that participants highlighted was staff retention issues, safety issues, quality issues and productivity issues. Developing your front-line leadership team can be a great way to reduce staff turnover, boost productivity and reduce safety and quality issues.

What is a frontline leadership training?

Front-line leadership is the management and supervision of front-line workers, overseeing all value-adding activities and procedures. Critical to the day to day operation of a business, front-line supervisors have a direct influence on the overall success of the organisation. Poor leadership has been directly correlated with employee dissatisfaction, low employee morale, and high turnover. Effective front-line leadership can foster higher levels of employee engagement, performance, employee satisfaction, and organisational success.

Front-line leadership training is the process of improving the quality and competency of front-line leaders within an organisation. This training can occur via internal training procedures, or via external parties who can offer a more objective view of an organisations areas for improvement.

What current option does this replace?

Front-line leadership training deals primarily with human resources, and is especially important in a labour intensive industry such as meat processing. Front-line leadership training is less about replacing current technologies, and more about allowing organisations to be more effective with their existing technologies and resources.

Why is it better? Who would benefit from it?

Employees are a crucial aspect of any organisation, but especially in labour intensive industries such as meat processing. More than simply having employees, skilled labour has been identified as being crucial to the success of an organisation across a wide variety of industries.[23] With front-line leaders playing a crucial role in the performance of front-line workers, the upskilling of front-line management is an effective way to improve not only their work performance, but general employee performance and overall organisational success.

Quality leadership and management has also been linked strongly with employee retention. having high quality supervisors has been cited as a significant factor when determining an employee's long term relationship with an organisation.[24] Front-line leaders represent the primary contact with the organisation for most employees. They play an important role in the retention and overall job satisfaction within an organisation, with employees reporting that over 40% of their negative experiences at work were directly

[23] (Maamari & Alameh, 2016)
[24] (Ellett, et al., 2007) & (W.G., et al., 2011)

related to the performance of their supervisor.[25] Therefore the more capable and qualified leaders can also lead to better employee retention and overall job satisfaction.

What are the limitations and challenges?

Although there are a wide variety of benefits from front line leadership training, problems can arise when supervisors cannot apply training to their work environment.

For leadership training to impact organisational performance, organisation should be receptive to change. Barriers to change, such as poor implementation, internal resistance, lack of communication, or inadequate training, present challenges to the implementation of leadership training that need to be overcome to ensure its success.

Where can I find out more?

Frontline leadership training can be implemented either via internal processes, or via enlisting external services. Employee training course are offered by a wide number of institutions, ranging from short courses, workshops, and seminars, to diplomas, certificates, and degrees.

Please ensure you discuss this with NIRAS Australia or your AMPC Co-Innovation manager for the latest most relevant providers that can assist you with all options contained in this report. In some cases, funding may be available for the adoption of your improvement project so please also discuss this with your AMPC representative.

The most up to date list of the current AMPC team members can be found at “Our Team” on the AMPC website - https://www.ampc.com.au/about-us/our-team

NIRAS Australia can be contacted on: **E: glja@niras.com**

Alternatively, some institutes and consultants that can help develop your leadership team Include:

- Seed People Consulting - https://seedpeopleconsulting.com.au/
- Mark Oliver (Mark Two Consulting) - https://www.marktwoconsulting.com/
- There are also many universities and training organisations around Australia that have frontline leadership courses which could be what you are looking for.

Useful links and reference material

Harvard Business Review – The Frontline Advantage
https://hbr.org/2011/05/the-frontline-advantage

Harvard Business Review - Why Leadership Training Fails and What to Do About It
https://hbr.org/2016/10/why-leadership-training-fails-and-what-to-do-about-it

[25] (Woohoo inc., 2019)

Promotion of a Healthy Work Culture

Capital Cost : Low
Safety Hierarchy of Control : Administration (4)
Operational Improvement : Better employee retention, better operational efficiencies, better safety awareness, better quality awareness, better employee engagement, better employee performance, better employee satisfaction, and better organisational success.

What is the issue at hand?

During the site studies, common themes that participants highlighted were staff retention issues, safety issues, quality issues and productivity issues. Similar to front line leadership training, promoting a healthy work culture can be a great way to reduce staff turnover, improve safety, improve product quality and boost productivity.

What is a Healthy Work Culture?

Upon further discussion with one of the participating sites, they had an emphasis on improving the culture in the cold store. NIRAS found that the site had higher rates of staff retainment and fewer LTIs. The interviewee established that the site had put importance on their work culture and training regime to improve the overall staff well-being. This resulted in an improved morale in the workforce with staff wanting to stay longer with appropriate treatment. The site embodies a "family-like" culture that encourages staff participation, providing them more psychological reasons to stay.

IMAGE 4 – TEAMWORK

One of the biggest challenges the small to medium size processors have highlighted is their challenges with staff shortages and staff retention. In the case study detailed above and many others alike, building a good culture has been proven to have a positive impact on performance, staff retention and staff reliability[26], with the particular site stating that it had more of a positive improvement on performance than some capital investment projects recently executed.

What current option does this replace?

This is a solution that complements other training and technology solutions detailed in the handbook. This can be done in parallel with other projects and can help reduce recruitment fees and foster higher levels of employee engagement, performance, employee satisfaction, and organisational success.

Why is it better? Who would benefit from it?

If it is executed correctly improvements can be observed in employees attitude towards occupational health & safety, quality control, absenteeism and property damage. Employees will be more engaged and

[26] (Maamari & Alameh, 2016)

alert when it comes to identifying quality issues and safety risks. Their performance will improve and they will tend to look for solutions and identify and resolve issues more efficiently.

What are the limitations and challenges?

Unlike installing new equipment, results are not immediate. Some organisations who start a training and cultural improvement regime part ways with it without getting the full benefits of the results.

Where can I find this technology?

There are many online resources that can help you understand what steps can be taken to improve the culture on the site or in a certain area. Practices can be implemented either via internal processes, or enlisting external services and consultants.

Please ensure you discuss this with NIRAS Australia or your AMPC Co-Innovation manager for the latest and most relevant providers that can assist you with all options contained in this report. In some cases, funding may be available for the adoption of your improvement project so please also discuss this with your AMPC representative.

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NIRAS Australia can be contacted on: **E: glja@niras.com**

Alternatively, some consultants and providers that can help in this area are as follows:

- Growth Culture - https://www.growthculture.io/
- Seed People Consulting - https://seedpeopleconsulting.com.au/

Useful links and reference material

Harvard Business Review - Proof That Positive Work Cultures Are More Productive
https://hbr.org/2015/12/proof-that-positive-work-cultures-are-more-productive

Business News Daily - How to Improve Your Company Culture
https://www.businessnewsdaily.com/5935-improve-company-culture.html

Automated Sorting & Retrieval Systems (AS/RS)

Capital Cost : Very High ($1.5 million +)
Safety Hierarchy of Control : Engineering (3)
Operational Improvements : Reduce manual handling hazards, reduce forklift interactions with personnel, reduce product damage from manual processes, can improve space utilisation, reduce labour requirements and improve operation performance.

An ASRS multi-shuttle can come in many sizes however, the cost are very high as they require building works and a large amount of automation. This option is not recommended for processors running less than 9 cartons per min.

What is the issue at hand?

Sorting and palletising cartons is commonly a manually intensive task requiring several operators to handle several SKUs at once. This also leads to having several more pallets on ground to accommodate for several SKUs, requiring more footprint. In addition to this, it can also be a hazard to operators due to the need to navigate through several pallets and carry boxes long distances.

What is an Automated Sorting & Retrieval System?

Automated Storage and Retrieval Systems (AS/RS) work by taking a cartons of certain SKUs and product codes and temporarily placing the carton into a location in racking. When a full pallet worth of the product is available, the cartons are then retrieved from the racking and sent out to the palletisation process. There are two commonly available systems that many larger processors have installed which include Stacker Crane Systems and Carton Multi-Shuttle Buffer Systems:

Stacker Crane Systems – A crane runs up and down the aisle putting cartons in various locations till a full pallet of the SKU is in the storage system. It then goes and retrieves the stored cartons and sends the product to the palletiser.

Multi-Shuttle Systems – Automated shuttles and cranes are utilized to put cartons in various locations till a full pallet of the SKU is in the storage system. They then go and retrieves the stored cartons and send the full pallet of the SKU to the palletiser.[27] Unlike a stacker crane, the multi shuttle has a shuttle to transport cartons on each level, this increases the carton sorting speed to double of the stacker crane system

[27] (Automation, 2022)

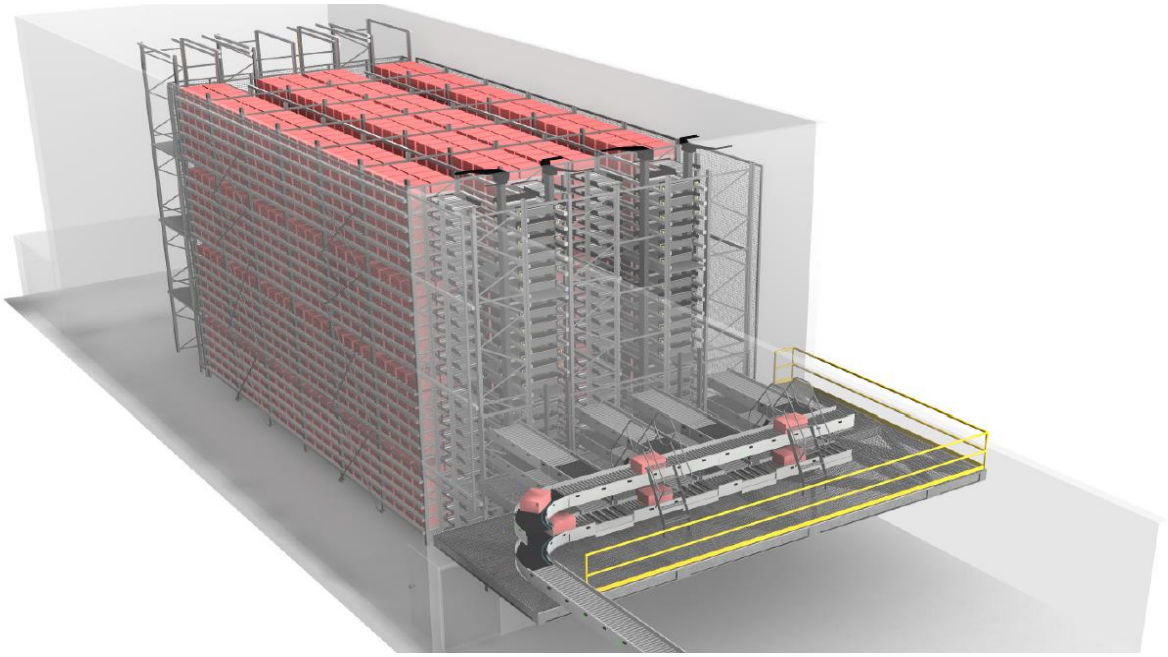


IMAGE 17 – DEMATIC ASRS MULTI-SHUTTLE CONCEPT

What current technology does it replace?

This can replace existing manual or semi-automated carton sorting process that can be combined with an automated palletiser. Currently, most small to medium size sites handle unsorted cartons through a single conveyor. The sorting and palletisation process from there is manual, requiring operators to manage several carton types and pallet types on the spot. By including an automated sorting and palletising system you can remove the manual handling processes and alleviate the safety hazards.

Why is it better? Who would benefit from it?

A fully automated carton sorting system can streamline and optimise the backend of the operation significantly. This can benefit owners by reducing safety hazards, property damage, product damage, labour requirements, forklift interactions with personnel and quality issues. For a facility sorting 10 cartons per min on one shift, labour savings can be between 6 - 12 people, and operational costs savings which include safety costs, property damage and product damage can also be reduced.

Capacity	10 cartons per min
Simple Payback	4 to 5 years
Construction Costs	$500k to $1m
Equipment Costs	$2,2m to $2.9m
Labour Savings*	$540k to $1.1m
Footprint	30m x 7m

* Labour savings are based off $90k per person. Savings exclude safety cost saving, property damage and product damage savings.

What are the limitations and challenges?

Very high capital costs can make it hard for small to medium size processors to justify a stacker crane or multi-shuttle systems.

Sortation systems can require large amount of footprint and height. Sortation systems strongly benefit from having high ceiling heights for carton vs footprint efficiency.

High Level Common Details

The typical specs for an average ASRS are:

Average maximum handling rate per aisle:	10	cartons/min

Affecting factors:

- Aisle levels/total height
- Aisle length
- Steadiness of infeed rate

Carton density per layer (excl. carton elevator & accesses:	1.8 to 2.3	cartons/m2/layer

Estimated Recommended Requirements

Typical no. of recommended length by carton:	25+	cartons long
Typical no. of recommended layers:	16+	layers/aisle
Typical recommended rate:	9	cartons/min

Details above are for reference only. Every ASRS system will have varying specification and requirements.

Where can I find out more?

Automated Carton Sorting and Retrieval Systems are available commercially. There are many Automated Carton Sorting and Retrieval Systems suppliers based here in Australia and internationally.

Please discuss this with NIRAS Australia or your AMPC Co-Innovation Manager to be put in contact with the best providers for your business. In some cases, funding may be available for the adoption of your improvement project so please also discuss this with your AMPC representative.

NIRAS Australia can be contacted on: **E: glja@niras.com**

The most up to date list of the current AMPC team members can be found at “Our Team” on the AMPC website - https://www.ampc.com.au/about-us/our-team

Alternatively, some suppliers that specialise in the delivery of AS/RS systems include:

- Dematic - https://www.dematic.com/en-au/
- Scott Automation - https://scottautomation.com/en/
- Schaefer - https://www.ssi-schaefer.com/en-au
- Swiss Log - https://www.swisslog.com/en-au

Useful links and reference material

N/A

Carton Accumulation Sorting System

Capital Cost : Medium – High ($800k - $2 million)
Safety Hierarchy of Control : Engineering (3)
Operational Improvements : Reduce manual handling hazards, reduce forklift interactions with personnel, reduce product damage from manual processes, improve space utilisation, reduce labour requirements and improve operation performance.

What is the issue at hand?

Issues are similar to what has been detailed in the AS/RS section above. Sorting and palletising cartons is commonly a manually intensive task requiring several operators to handle several SKUs at once. This also leads to having several more pallets on ground to accommodate for multiple SKUs, requiring more footprint. In addition to this, it can also be a hazard to operators due to the need to navigate through several pallets and carry boxes long distances.

What is a Carton Accumulation Sorting System?

Carton Accumulation Systems work by diverting selected SKUs to an accumulation conveyor where the product can be stored while a full pallet worth of the product (36-42 cartons) is being built up. The dimensions of the systems can be modified to fit in areas of varying footprint and the height and the size can also be increased or decreased depending on how many SKUs you want to design it for.

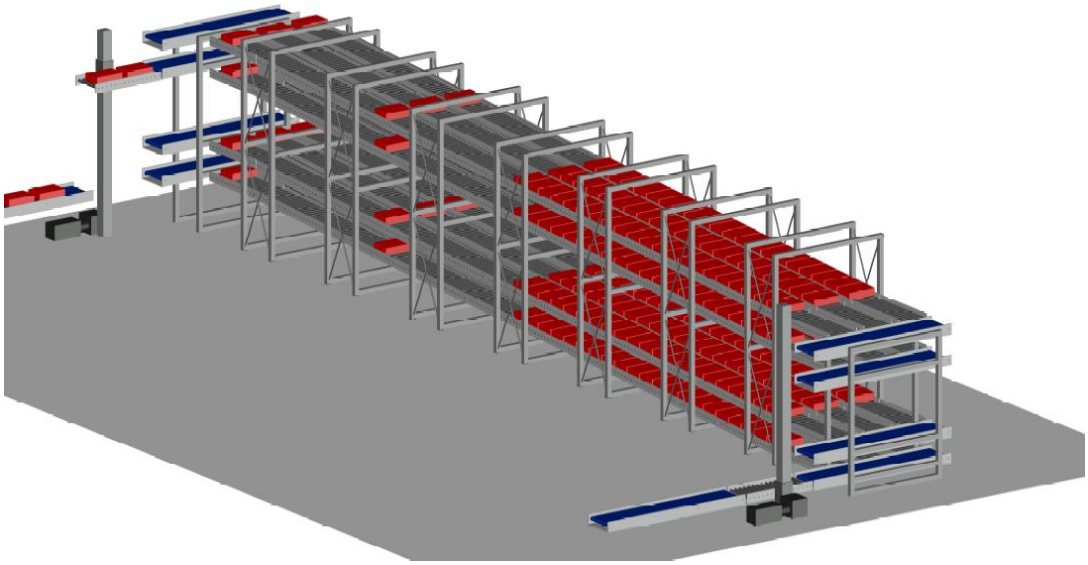


IMAGE 18 – CONCEPT DESIGN OF A CARTON ACCUMULATION SORTING SYSTEM

The idea of the carton accumulation systems designed for small to medium size facilities is to sort only the major throughput SKUs. Rather than having a large system that is costly and complex, carton accumulation systems could be utilised to sort 12 or 24 or more of your major SKUs running at any given time to reduce the amount of manual sorting and palletising being completed. The basic concept of the system could incorporate 2 carton lifters and 12, 24 or more sets of conveyors layered vertically. By default, each conveyor can occupy 36 - 42 cartons, which equates to the standard carton arrangement on pallets (6-7 layers of 6 cartons). Unsorted cartons are scanned for its SKU identification and sent to a carton

elevator, where the elevator takes the carton to a designated isle conveyor for that SKU. When the isle conveyor is full with the 36 or 42 cartons of the same SKU, the conveyor unloads all the cartons to be sent to palletisation.

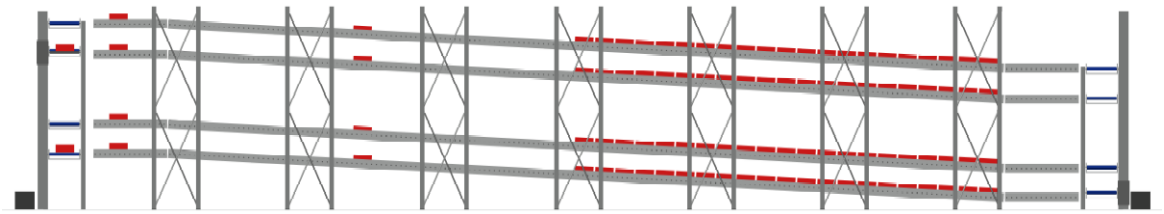
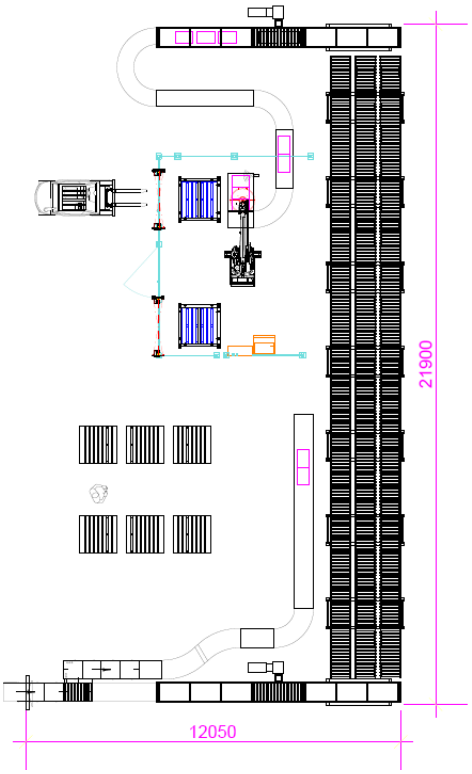


IMAGE 19 – CONCEPT DESIGN OF A CARTON ACCUMULATION SORTING SYSTEM

What current technology does it replace?

An accumulation sortation system can operate alongside manual sporting and palletising practices, or replace them all together. With a 12 or 24 SKU accumulation conveyor system operating beside the manual palletisation area, operators will have the option to send the SKUs they don't want to sort and palletise manually to the accumulation conveyors/racking where it will build up with cartons till a full pallet is available to be sent out. As all the cartons will come out together as one SKU type, the business also has the option of installing an automated palletising, rapping and labelling system as well.



DRAWING 2 – CONCEPT DRAWING

Why is it better? Who would benefit from it?

An automated carton accumulation system can streamline and optimise the backend of the operation significantly. This can benefit owners by reducing safety hazards, property damage, product damage, labour requirements, forklift interactions with personnel and quality issues.

By including a carton accumulation system in your plant, you could sort and palletise your 12 or 24 major SKUs automatically. Operators will have far fewer cartons/SKUs to palletise, minimizing transversal of a variety of pallets and chances of incorrect cartons being palletised. For a facility running at 5 cartons per min you could go from having 1 forklift operator and 5-8 people sorting, to 1 forklift operator and 1 person sorting. Safety issues, product rework issues, property damage and product damage can also be reduced which some sites stating that rework and safety can cost them between $40k to $80k p.a.

Capacity	5 cartons per min – Sorts 12 SKUs
Simple Payback	2 to 3.5 years
Construction Costs	$140k to $300k
Equipment Costs	$1.1m to $1.6m
Labour Savings**	$360k to $640k
Footprint	22m x 6 m

* Labour savings are based off $90k per person. Savings exclude safety cost saving, property damage and product damage costs.

What are the limitations and challenges?

This design detailed above is a concept accumulation system developed by NIRAS. This has been adapted from existing technologies overseas in the pork industry. Currently this concept does not appear to be used in the Australian Red Meat Industry and detailed design would need to be completed further.

Sortation systems do require floor space and height. Sortation systems strongly benefit from having high ceiling heights (to an extent) for carton vs footprint efficiency however this 12 SKU concept above is no higher than 4.5m.

Medium to High capital cost could be hard for a small to medium size processor to justify the investment however if there are a number of operators currently sorting pallets then it may become feasible and provide a good ROI.

Where can I find out more?

The automated carton accumulation systems detailed in this guide is a concept design and will need to be developed and implemented. There are local automation and conveyor suppliers that could assist with the detailed design of the concept system.

Please discuss this with NIRAS Australia of your AMPC Co-Innovation Manager to be put in contact with the best providers for your business. In some cases, funding may be available for the adoption of your improvement project so please also discuss this with your AMPC Co-Innovation Manager.

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Useful links and reference material

N/A

Palletisers

Capital Cost : Medium / High ($430k - $1.5 mil)
Safety Hierarchy of Control : Engineering (3)
Operational Improvements : Reduce manual handling hazards, reduce forklift interactions with personnel, reduce product damage from manual processes, can improve space utilisation, reduce labour requirements and can improve operation performance.

What is the issue at hand?

Issues are similar to what has been detailed in the AS/RS section above.

Automatic palletisation can become a feasible option if you can implement either of the carton sorting systems detailed above.

What are Carton Palletiser?

Palletisers are getting more compact and more affordable and if automatic carton sorting is achieved then complementing it with an automated palletisation solution may be a good option for your business. There are a number of different options that should be investigated when choosing the right palletiser system for your business and you may also want to include pallet wrapping and pallet labelling applications too.

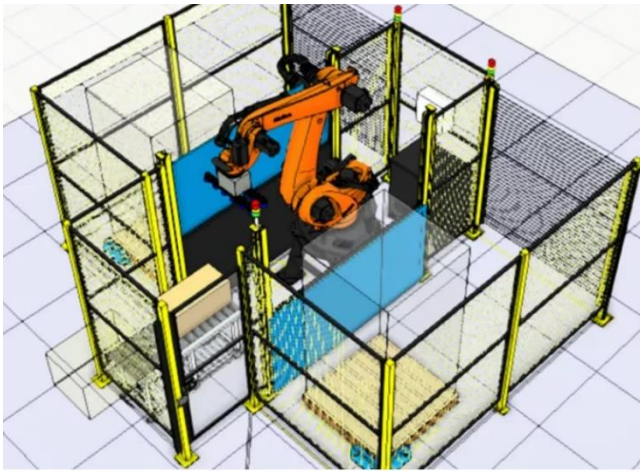

IMAGE 20 – SMALL FOOTPRINT ROBOT PALLETISER

Robot Palletisers – Robots are used to pick up 1 or more cartons at a time and place them onto a pallet in the allocated orientation and location. They normally have 2 pallet outlets so that one is being built while the other is being taken away as shown in the image to the right.

Layer Palletisers – if you are palletising many identical products per minute like most processors, there is a possibility that a no robotic palletiser could be a good option for your business. Layer palletiser can be both large and compact depending on the capacity you require. They are multi-level machines that build each pallet layer on a table using conveyors and actuators. The built layer is then lowered onto the empty pallet and release or gently dropped without disrupting the layer formation. The next layer is then built and placed on top of the last.

Cobot Palletisers – are a new technology that can operate alongside personnel, without fencing. They have sensors on them so that they can speed up or slow down when people are in close proximity. Commonly they are used to do lighter activities but the technology is developing and they have been known to be used to palletise cartons.

What current technology does it replace?

If an automated carton sorting system is installed then an automated palletising system can also be installed to palletise the pre-sorted cartons. This technology replaces the need for manual palletisation of products.

Why is it better? Who would benefit from it?

A palletiser will help to streamline the operation, reduce manual handling of sometimes heavy cartons (27kg), reduce forklift interaction with personnel, reduce product damage from manual processes, can improve space utilisation and can reduce labour requirements by 1-3 operators for a place running 6 cartons per min on day shift only.

Capacity	3.5 to 4 picks per min
Simple Payback*	2.5 to 4 years
Construction Costs	$40k to $70k
Equipment Costs	$430k to $600k
Labour Savings*	$90k to $270k
Footprint	6.4m x 4.5m

* Robotic grippers can be modified to handle multiple cartons at a time

* Labour savings are based off $90k per person. Savings exclude safety cost saving, property damage and product damage savings.

What are the limitations and challenges?

It is best to implement an automated carton sorting system before a palletiser is considered. Some sites have installed many palletisers for a number of SKUs but this can become an expensive and space consuming option.

Medium to High capital cost could be hard for a small to medium size processor to justify the investment.

High capacity robots can require a high clearance to pick and place products onto pallets.

Suppliers will need to design robot palletisers for cold store conditions to prevent components from freezing.

IMAGE 21 – LAYER PALLETISER

Where can I find out more?

Automated Palletisation Systems are available commercially. There are several Palletisation suppliers in Australia and many international providers too.

Please discuss this with your AMPC Co-Innovation Manager or NIRAS Australia to be put in contact with the best providers for your business. In some cases, funding may be available for the adoption of your improvement project so please also discuss this with your AMPC representative.

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NIRAS Australia can be contacted on: **E: glja@niras.com**

Alternatively, some suppliers that specialise in the delivery of palletisation systems include:

- Scott Automation - https://scottautomation.com/en/

- Automation Solutions - https://www.automationsolutions.com.au/
- Foodmach - https://foodmach.com/

Useful links and reference material

How to choose the right palletiser system - https://robodk.com/blog/robot-palletizing-system-choice/

Improved Segregation of Forklifts and Pedestrians

Capital Cost : Low / Medium ($50k - $300k)
Safety Hierarchy of Control : Depends on layout improvement
Operational Improvements : Improve operational efficiency, reduce manual handling requirements, reduce forklift requirement, reduce forklift interactions, improve space allocation, reduce labour requirements, consolidate like processes and reduce property damage by forklifts.

What is the issue at hand?

In some of the small to medium size sites observed, forklifts and pedestrians are seen to frequently occupy the same space and pathways. Commonly this can occur because a business has grown without consideration of logistics and workflow. Without effective consideration it can result in an increased risk of an accident or near-miss incident.

What is improved segregation for forklifts and pedestrians?

One of the main issues discussed during the site studies was the lack of space and spatial optimisation of plants. Many plants were found to have shared spaces for forklifts and pedestrians, resulting in more frequent accidents or near misses, especially around blind spots, corners, and doorways. There are several ways in optimizing spatial availability, whether it would be effectively organising equipment to maximize trafficable spaces, detailed analysis and rearrangement of production workflow, and consolidating similar process sectors into one area.

What current option does this replace?

While this solution is an advisory-analysis based service, there may be suggestions of replacement, movement, and relocation of a variety of equipment involved.

Why is it better? Who would benefit from it?

Improving the segregation of pedestrians and forklifts will improve operational efficiency and the speed of pallet handling, reduce product rework, reduce labour requirements, achieve better safety standards, consolidate like processors and reduce property damage.

What are the limitations and challenges?

As this solution is very site-centric, it would require specialised attention to each site due to differences in site layouts. The effectivity of site reorganization will also be determined on the spatial availability.

Equipment relocation and room modifications will require time and funding. Depending on the scale, it may halt operations for periods while works are occurring. Appropriate management can help mitigate the impact on the business operations.

Where can I find out more?

Consultants such as NIRAS specialising in process optimisation of red meat industry can assist with site auditing and advising necessary improvements. Each consultancy group will have a myriad of experience and resources, depending on their outside-industry experience and global reach.

Please discuss this with NIRAS Australia or your AMPC Co-Innovation Manager to be put in contact with the best providers for your business. In some cases, funding may be available for the adoption of your improvement project so please also discuss this with your AMPC representative.

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Useful links and reference material

N/A

Automated Guided Vehicle (AGVs)

Capital Cost : Medium ($300k - $500k each)
Safety Hierarchy of Control : Engineering (3)
Operational Improvements : Improve safety, reduce forklift interactions, improve space allocation, consolidate like processes, reduce forklift and labour requirement, and reduce property damage from forklifts.

What is the issue at hand?

Forklifts are usually manually operated. This introduces risk due to human errors and accidents due to forklift crashing are not uncommon. Additionally, with the ever-increasing shortage of labour, operations may be heavily impacted if no adequate labour can be sourced.

What are AGVs?

AGVs are vehicles that can operate without direct human intervention and relies on specific navigational methods to determine its current position and pathfinding ability. AGVs comes in various different forms and have been used across several different industries, such as pharmaceutical, health care, food processing, and others involving logistic processes.

Navigational Systems

There are several navigational methods that are widely used for AGVs, to name a few, there are:

Laser Navigation: Laser-based system that relies on reflectors placed in several different spots within the facility,

Pathway Guidance: Vehicle that follows a trail of a specific material/properties on the floor. Common ones are inductive wire navigation (requiring the wire to be installed in the floor), magnetic tape navigation (non-invasive installation), and floor tags,

Natural navigation: Utilises pathfinding techniques through a LiDAR system to map the environment by emitting and receiving reflected laser beams.[28]

IMAGE 22 – DEMATIC TABLE TOP AGV

Machine Learning: Recent trials with the use of virtual reality environments have allowed advancements in AGVs with dealing with dynamic scenarios, such as avoiding obstructions and traffic, switching of actions

[28] (Reyner, n.d.) & (Reyner, n.d.) & (Tella, n.d.)

IMAGE 23 – SQUID AGV

according to priorities, smoother routing and less frequent starts and stops, etc. Currently, its being tested in virtual environments where tests can be conducted at much higher rate and easily optimised. Its potential is still being assessed at this stage, and in future advancements, can aid in the planning of AGVs' usage to specific sites with far less real-world trial and error.[29] [30]

Functional Variations

While commonly associated as an inspiration from a traditional forklift within the warehousing space, there are also other AGVs that offer different functions and builds.

Robotic Attachment: An AGV with robotic attachments. This can be a mobile platform mounted with a robotic arm, which can also assist with transporting cartons or smaller objects around the site. Useful for handling low capacity SKU orders.

Tugger AGV: An AGV with the ability to latch and tow carts, vehicles, and can be also be used to transport pallets on pallet dollies, providing more versatility.

Unit Load AGV/AGC (Cart versions): Compact vehicle capable of transporting pallets but some with lesser ability than traditional forklift AGVs with depositing pallets into higher shelves.

What current technology does it replace?

The technology aims to replace human intervention in the logistics landscape, such as human-operated forklift activities transporting pallets, manual handling of carton transportation, assistance with transporting spare parts, machine parts for maintenance, etc.

Why is it better? Who would benefit from it?

AGVs can be used to make operations safer by replacing manual tasks with automation. This benefits the business by reducing safety hazards, property damage, labour requirements and property damage in the warehouse area.

Due to the autonomous nature of the system, safety precaution techniques are developed with upmost priority, and with years of development, have only gotten better. This means less injuries for operators, and less OH&S issues for management.

Capacity	1 AGV – 90m/min
Simple Payback	2.5 to 4 years
Equipment Costs	$330k to $520k
Labour Savings	$90k to $180k

* Labour savings are based off $90k per person. Savings exclude safety cost saving, property damage and product damage savings.

[29] (Oyekanlu, et al., 2020)
[30] (Popper, et al., 2021)

What are the limitations and challenges?

Due to the complexities involved with technical components and program protocols, they can have a medium to high capital cost. Each navigation system have varying maintenance routine and cost involved.

Most AGVs do not work well when operating in shared zones, it is normally recommended to have designated areas free-of-traffic and obstacles to get the highest operation efficiency.

Most AGVs have been known to have difficulties adjusting to differential temperature and humidity, i.e. moving in and out of blast freezers. You may require individual systems for each environment.

Currently, the technology is mostly beneficial for larger operations but the AGV technology and navigation systems are developing rapidly and it is likely that AGVs may continue to be a more cost effective option for small and medium size processors .

Where can I find out more?

AGVs are available commercially and locally. Several suppliers in Australia have been referred to as leaders of AGV technologies.

Please discuss this with your AMPC Co-Innovation Manager or NIRAS Australia to be put in contact with the best providers for your business. In some cases, funding may be available for the adoption of your improvement project so please also discuss this with your AMPC representative.

The most up to date list of the current AMPC team members can be found at “Our Team” on the AMPC website - https://www.ampc.com.au/about-us/our-team

NIRAS Australia can be contacted on: **E: glja@niras.com**

Alternatively, some suppliers that specialise in the delivery of these systems include:

- Dematic - https://www.dematic.com/en-au/
- Toyota - https://www.toyotamaterialhandling.com.au/automation-solutions/

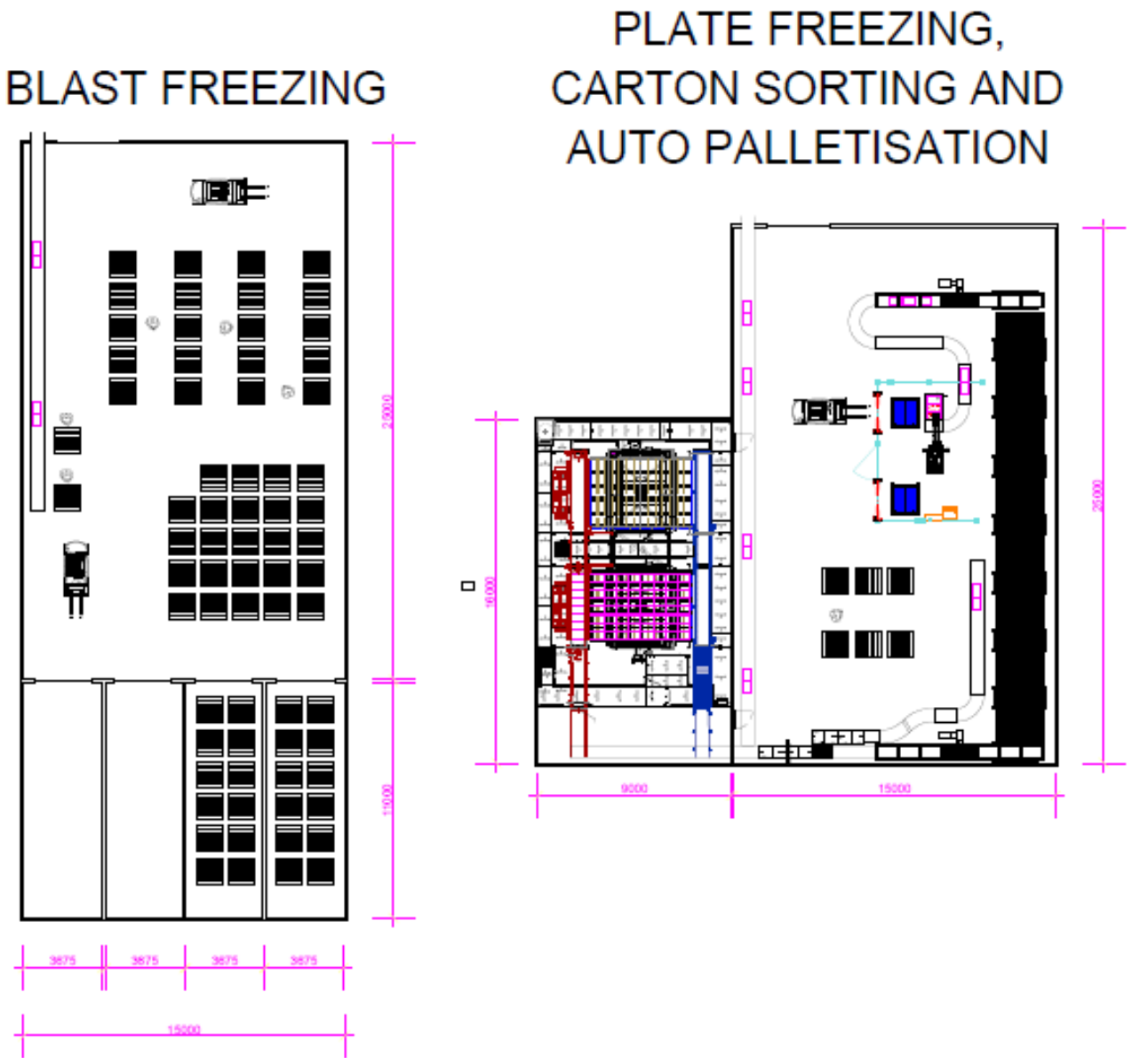
Useful links and Reference material

The Evolution of AGVs - https://www.powertransmission.com/blog/the-evolution-of-agvs/

Different AGVs and Navigation Methods - https://guide.directindustry.com/choosing-the-right-agv/

Case Study – Example of how handling and storage can be improved for a small to medium size processor

Example Site A is freezing 1,400 cartons per day and sorting and palletising the remaining 1,800 cartoned products. They have been operating 4 x 760 carton capacity blast freezers and have 2-4 operators loading cartons into stillages, 2 full time forklift operators moving stillages into the blast freezers and moving finished goods pallets into freezer rooms, and 4-6 operators unloading the stillages and making up full pallets.



DRAWING 3 – CASE STUDY SHOWING HOW SITES COULD AUTOMATE FREEZING, CARTON SORTING AND PALLETISATION

Example Site A is having troubles sourcing staff to work in the cold store area and has had issues with staff not lifting cartons correctly and injuring themselves. This is having an impact on the businesses performance because the site doesn't have enough people to work in this area.

The site complete a review of their operation and realise that they can improve safety and reduce their dependency on personnel by building a new area for 2 plate freezers with the capacity of 1,520 cartons per day each. They decommissioned the old, inefficient blast freezers and then also installed a carton accumulation sorting system with a palletiser which can sorted and palletised 12 of their major SKUs leaving only a few smaller SKU items to be palletised manually.

The example budget building works and equipment installation and commissioning was determined to cost between $2.8m to $3.4m.

- Through freezing efficiency improvements they saved $40k to $55k p.a. in electricity costs,
- Through automation improvements they saved 9 operators and only needed 1 operator to sort the smaller SKUs manually and 1 forklift driver to wrap label and store the finished goods pallets,
- They had less safety issues, less recruitment costs, less product damage, less rework issues, and had one less forklift,
- One thing that hadn't been accounted for was that because they were now freezing the product in a plate freezer, the cartons were more uniform and they could load 9% more into a container, thus reducing there container load fees too,
- They had less downtime and disruption at the back end of the operation resulting in their efficiency and DIFOT (Delivery In Full On Time) going up.

Unit Capacity	3-4 cartons/min
Simple Payback	2.5 to 4 years
Building Costs	$450k to $600k
Equipment Costs	$2.4m to $3.1m
Labour Savings*	$900k
Power Savings*	$40k to $55k
Footprint (remove blast freezers and add plate freezers)	Less floor space taken

* Additional revenue from throughput improvements has been excluded.

* Labour savings are based off $90k per person. Savings exclude safety cost saving, property damage and product damage savings.

* Power savings are calculated off $0.06 per kWh

* This excludes container load saving which could be an additional $100k to $600k per year as other sites have experienced.

Overview

NIRAS would like to thank everyone that was involved in developing this guide which includes AMPC Managers, participating sites and suppliers. As every site is different, ideal solutions will vary for each individual site and thus it is important to complete a thorough master plan to determine which solutions will present the best payback. The order in which to roll out these solutions can then be prioritises. This guide is a reference for the most up to date technologies and options to streamline your operation and improve safety in the carton handling and storage area. As detailed, the most beneficial solutions will vary for each site and the paybacks for each solution will obviously be better or worse depending on how your site is currently being operated.

As a high level overview, technologies and solutions that present a good payback and helps to overcome many of the issues present in the industry include:

- Plate Freezers,
- Concept Carton Accumulation Sorting System with an Automated Palletiser,
- Automated Palletisers,
- Automated Stillage Loader and Unloader (if you cannot justify a plate freezer,)
- Automated Guided Vehicals,
- Carton Design Review and Optimisation,
- Frontline Leadership Training for Supervisors,
- Promotion of a Healthy Work Culture,
- Carton Compactors before the Carton Lidder,
- Exoskeleton suits as standard PPE (Cost between $1.2k to $14k,)
- Review site layout and identify ways to improve forklift and pedestrian segregation,
- Optimised Racking Solutions.

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Appendices

Appendix 1 – Primary Safety and Operational concerns

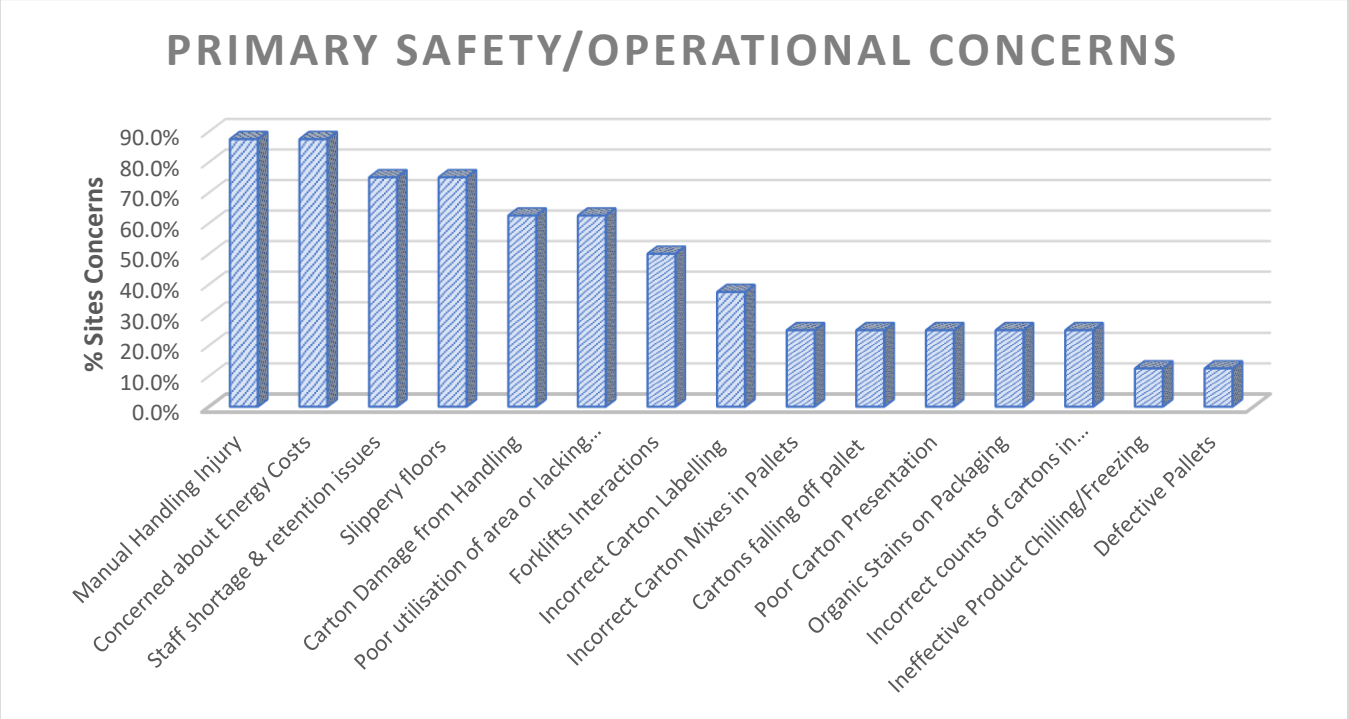


Chart 5 – Primary operational concerns obtained from industry participants

Appendix 2 – Technology and Options Analysis

The following section details how each option was assessed and graded in terms of their impact on the corresponding issues

Solution / Issues	Staff Shortage	Personal Injury	Forklift Interaction	Carton Presentation	Space Utilisation	Carton Handling Damages	Miscount of Cartons	Energy Usage	Invalid Caron Labels	Organic Stains on Cartons	Slipping Hazards	Unstable Pallet Stacks	Cartons Stuck on Stillages	Defective Pallets	Incorrect Carton Mixes	Total Score	Effectivity %
Plate Freezers	5	5	3	5	5	5	1	5	0	0	5	4	5	0	0	48	64.0%
Carton Sorting System	5	5	5	3	4	3	4	0	5	0	4	0	0	0	5	43	57.3%
Carton Accumulation System	5	5	5	3	4	3	4	0	5	0	4	0	0	0	5	43	57.3%
Palletisation	4	5	5	3	1	3	3	0	5	0	3	4	0	2	5	43	57.3%
Automated Blast Freezers	5	5	3	4	5	5	0	3	0	0	5	0	0	0	0	35	46.7%
AGV	5	5	5	0	0	5	0	4	0	0	5	0	0	5	0	34	45.3%
Healthy Work Culture	3	2	2	2	0	2	2	2	2	3	2	2	2	2	2	30	40.0%
Frontline Leadership Training	3	2	2	2	0	2	2	2	2	3	2	2	2	2	2	30	40.0%
Exoskeleton Suit	3	4	0	4	0	3	1	0	1	0	2	3	0	3	0	24	32.0%
Auto Stillage Loader & Unloader	5	5	4	0	2	4	0	0	0	0	4	0	0	0	0	24	32.0%

Optimised Racking	3	3	3	0	5	3	0	3	0	0	0	0	0	4	0	24	32.0%
Vacuum Lifters	3	4	0	4	0	3	0	0	1	0	2	3	0	3	0	23	30.7%
Ped & Forklift Segregation	1	3	3	2	3	2	0	0	0	0	3	0	0	3	1	21	28.0%
Carton Design Optimisation	2	1	0	5	0	3	1	0	0	0	0	4	5	0	0	21	28.0%
Carton Compactor	2	1	0	5	0	3	1	0	0	0	0	4	4	0	0	20	26.7%

Healthy Work Culture

Issues Addressed	Reasoning
Staff Shortages	Content employees promotes better staff retention
Personal Injury	Improved awareness towards safety issues
Forklift Interaction	Improved awareness towards safety issues
Carton Presentation	Improved awareness towards quality issues
Space Utilisation	N/A
Carton Handling Damages	Improved awareness towards quality & safety issues
Miscount of Cartons	Improved awareness towards quality issues
Energy Usage	Improvement of employees awareness of working environment impact from external sources
Invalid Carton Labels	Improved awareness towards quality issues
Organic Stains on Cartons	Improved awareness towards quality issues
Slipping Hazards	Improved attitude towards hazards
Unstable Pallet Stacks	Improved awareness towards quality & safety issues
Carton Stuck in Stillages	Improved awareness towards quality issues
Defective Pallets	Improved awareness towards quality issues
Incorrect Carton Mixes	Improved awareness towards quality issues

Frontline Leadership Training

Issues Addressed	Reasoning
Staff Shortages	Content employees promotes better staff retention
Personal Injury	Improved awareness towards safety issues
Forklift Interaction	Improved awareness towards safety issues
Carton Presentation	Improved awareness towards quality issues
Space Utilisation	N/A
Carton Handling Damages	Improved awareness towards quality & safety issues
Miscount of Cartons	Improved awareness towards quality issues
Energy Usage	Improvement of employees awareness of working environment impact from external sources
Invalid Carton Labels	Improved awareness towards quality issues
Organic Stains on Cartons	Improved awareness towards quality issues
Slipping Hazards	Improved attitude towards hazards
Unstable Pallet Stacks	Improved awareness towards quality & safety issues
Carton Stuck in Stillages	Improved awareness towards quality issues
Defective Pallets	Improved awareness towards quality issues
Incorrect Carton Mixes	Improved awareness towards quality issues

Pedestrian & Forklift Segregation

Issues Addressed	Reasoning
Staff Shortages	Safer environment promotes better staff retention
Personal Injury	Less forklift interaction results in less forklift accidents
Forklift Interaction	Segregated forklift interaction with pedestrians
Carton Presentation	Optimised pathing results in less obstacles that may cause damages to cartons
Space Utilisation	Optimised revision of pathing encourages optimised layout and placement of equipment
Carton Handling Damages	Optimised pathing results in less obstacles that may cause damages to cartons
Miscount of Cartons	N/A
Energy Usage	N/A
Invalid Carton Labels	N/A
Organic Stains on Cartons	N/A
Slipping Hazards	Optimised pathing that reduces the need to transverse into slippery places unnecessarily
Unstable Pallet Stacks	N/A
Carton Stuck in Stillages	N/A
Defective Pallets	Optimised pathing results in less obstacles that may cause damages to pallets
Incorrect Carton Mixes	Improved awareness towards quality issues

Exoskeleton Suit

Issues Addressed	Reasoning
Staff Shortages	People are more likely to find working conditions to be agreeable with lesser risk of injuries
Personal Injury	Mechanically supported device to alleviate heavy loads to manageable feats
Forklift Interaction	N/A
Carton Presentation	Cartons less likely to be damaged with the aid of devices promoting proper handling
Space Utilisation	N/A
Carton Handling Damages	Cartons less likely to be damaged with the aid of devices promoting proper handling
Miscount of Cartons	Less fatigued operators, more awareness of quality issues
Energy Usage	N/A
Invalid Carton Labels	Less fatigued operators, more awareness of quality issues when performing hourly checks
Organic Stains on Cartons	N/A
Slipping Hazards	Less fatigued operators, more awareness of safety
Unstable Pallet Stacks	Manageable loads, less constraints on palletising rates, more time to be mindful of handling.
Carton Stuck in Stillages	N/A
Defective Pallets	Easier handling promotes better capacity at handling products with care
Incorrect Carton Mixes	N/A

Vacuum Lifters

Issues Addressed	Reasoning
Staff Shortages	People are more likely to find working conditions to be agreeable with lesser risk of injuries
Personal Injury	Mechanically supported device to alleviate heavy loads to manageable feats
Forklift Interaction	N/A
Carton Presentation	Cartons less likely to be damaged with the aid of devices promoting proper handling
Space Utilisation	N/A
Carton Handling Damages	Cartons less likely to be damaged with the aid of devices promoting proper handling
Miscount of Cartons	Less fatigued operators, more awareness of quality issues
Energy Usage	N/A
Invalid Carton Labels	Less fatigued operators, more awareness of quality issues when performing hourly checks
Organic Stains on Cartons	N/A
Slipping Hazards	Less fatigued operators, more awareness of safety
Unstable Pallet Stacks	Manageable loads, less constraints on palletising rates, more time to be mindful of handling.
Carton Stuck in Stillages	N/A
Defective Pallets	Easier handling promotes better capacity at handling products with care
Incorrect Carton Mixes	N/A

Automatic Stillage Loader & Unloader

Issues Addressed	Reasoning
Staff Shortages	Takes out the need to load and unload stillages manually
Personal Injury	Takes out the need to load and unload stillages manually
Forklift Interaction	No forklift interactions as no operators to load and unload stillages manually
Carton Presentation	N/A
Space Utilisation	Can help to optimise space by reducing pedestrian pathway and area requirements
Carton Handling Damages	Procedure is more consistent and controlled with an automated process
Miscount of Cartons	N/A
Energy Usage	N/A
Invalid Carton Labels	N/A
Organic Stains on Cartons	N/A
Slipping Hazards	Eliminates labour transversal from carrying out task
Unstable Pallet Stacks	N/A
Carton Stuck in Stillages	N/A
Defective Pallets	N/A
Incorrect Carton Mixes	N/A

Automated Storage & Retrieval System

Issues Addressed	Reasoning
Staff Shortages	Less micro-managerial load of sorting prior to palletisation for operators, less labour required due to automation and promotes better environment for operators
Personal Injury	Less micro-management work, less stress, less need to hurry to keep up with rates
Forklift Interaction	Less movements to handle multiple SKUs, less people in area, less forklift interactions
Carton Presentation	Less micro-management work, less stress, less need to hurry to keep up with rates
Space Utilisation	Less variation of SKUs, less pallets on the floor
Carton Handling Damages	Less micro-management work, less stress, less need to hurry to keep up with rates
Miscount of Cartons	Carton counts are appropriately sorted beforehand
Energy Usage	N/A
Invalid Carton Labels	Automation of carton identification of labels
Organic Stains on Cartons	N/A
Slipping Hazards	Less movements to handle multiple SKUs
Unstable Pallet Stacks	N/A
Carton Stuck in Stillages	N/A
Defective Pallets	N/A
Incorrect Carton Mixes	Cartons are sorted respective to their SKUs pre-palletisation

Carton Accumulation System

Issues Addressed	Reasoning
Staff Shortages	Less micro-managerial load of sorting prior to palletisation for operators, less labour required due to automation and promotes better environment for operators
Personal Injury	Less micro-management work, less stress, less need to hurry to keep up with rates
Forklift Interaction	Less movements to handle multiple SKUs, less people in area, less forklift interactions
Carton Presentation	Less micro-management work, less stress, less need to hurry to keep up with rates
Space Utilisation	Less variation of SKUs, less pallets on the floor
Carton Handling Damages	Less micro-management work, less stress, less need to hurry to keep up with rates
Miscount of Cartons	Carton counts are appropriately sorted beforehand
Energy Usage	N/A
Invalid Carton Labels	Automation of carton identification of labels
Organic Stains on Cartons	N/A
Slipping Hazards	Less movements to handle multiple SKUs
Unstable Pallet Stacks	N/A
Carton Stuck in Stillages	N/A
Defective Pallets	N/A
Incorrect Carton Mixes	Cartons are sorted respective to their SKUs pre-palletisation

Palletising System

Issues Addressed	Reasoning
Staff Shortages	Takes out the need to carry out the work manually
Personal Injury	Takes out the need to carry out the work manually (no active operators to perform the process)
Forklift Interaction	No active operators between the interaction of forklifts and pallets
Carton Presentation	Automated process promotes less errors and improved care
Space Utilisation	N/A
Carton Handling Damages	Automated process promotes less errors and improved care
Miscount of Cartons	Utilises an inventory tracking system that counts the number of cartons on pallets
Energy Usage	N/A
Invalid Carton Labels	Scans carton SKUs to match with the appropriate pallet
Organic Stains on Cartons	N/A
Slipping Hazards	Takes out the need to have operators present to carry out the work manually
Unstable Pallet Stacks	Automated equipment improves placement accuracy
Carton Stuck in Stillages	N/A
Defective Pallets	Automated process promotes less errors and improved care
Incorrect Carton Mixes	Scans carton SKUs to match with the appropriate pallet

Automated Guided Vehicles

Issues Addressed	Reasoning
Staff Shortages	Takes out the need to carry out the work manually
Personal Injury	Automated process and detailed safety precautions means lesser errors of handling
Forklift Interaction	Most AGVs are equip with several overrides involving pedestrian contacts
Carton Presentation	N/A
Space Utilisation	N/A
Carton Handling Damages	Procedure is more consistent and controlled with an automated process
Miscount of Cartons	N/A
Energy Usage	Automated process promotes less mistakes, less expenditure of energy for correction
Invalid Carton Labels	N/A
Organic Stains on Cartons	N/A
Slipping Hazards	Less personnel intervention, less frequency of slipping
Unstable Pallet Stacks	N/A
Carton Stuck in Stillages	N/A
Defective Pallets	Automated process promotes less mistakes. Equipped with high functioning sensors and protocols
Incorrect Carton Mixes	N/A

Optimised Racking

Issues Addressed	Reasoning
Staff Shortages	Less transversal, less labour workload. Some racking options offer semi-automated handling (e.g.: shuttle racking, ASRS)
Personal Injury	Better pathway, less collision risk
Forklift Interaction	Better pathway, less collision risk
Carton Presentation	N/A
Space Utilisation	Optimised racking configuration to maximize potential storage area
Carton Handling Damages	Better pathway, less collision risk
Miscount of Cartons	N/A
Energy Usage	Less micro-managerial work, less forklift movements, less energy wasted
Invalid Carton Labels	N/A
Organic Stains on Cartons	N/A
Slipping Hazards	N/A
Unstable Pallet Stacks	N/A
Carton Stuck in Stillages	N/A
Defective Pallets	Better pathway, less collision risk
Incorrect Carton Mixes	N/A

Carton Compactor

Issues Addressed	Reasoning
Staff Shortages	Less rework from overfitted cartons and its consequences (e.g.: carton/pallet falling over due to bulging)
Personal Injury	Resolves issue with cartons overfitting, which may lead to improper product handling (e.g.: pallet instability from bulged cartons)
Forklift Interaction	N/A
Carton Presentation	Resolves issue with cartons overfitting as products when more compressed
Space Utilisation	N/A
Carton Handling Damages	Resolves issue with cartons overfitting, which may lead to improper product handling (e.g.: pallet instability from bulged cartons)
Miscount of Cartons	Less variability in carton shapes. Alleviates errors when counting visually
Energy Usage	N/A
Invalid Carton Labels	N/A
Organic Stains on Cartons	N/A
Slipping Hazards	N/A
Unstable Pallet Stacks	Resolves issue with cartons overfitting as products when more compressed
Carton Stuck in Stillages	Resolves issue with cartons overfitting as products when more compressed
Defective Pallets	N/A
Incorrect Carton Mixes	N/A

Carton Design Optimisation

Issues Addressed	Reasoning
Staff Shortages	Less rework from overfitted cartons and its consequences (e.g.: carton/pallet falling over due to bulging)
Personal Injury	Reduces issue with carton stack instability (stacked cartons falling onto personnel)
Forklift Interaction	N/A
Carton Presentation	Appropriately allocated space to fit in products
Space Utilisation	N/A
Carton Handling Damages	Overcome issues from overpacked cartons (bulging, stacking instability, strained carton, etc.)
Miscount of Cartons	Cartons have consistent levelling when palletised (reduced visual error)
Energy Usage	N/A
Invalid Carton Labels	N/A
Organic Stains on Cartons	N/A
Slipping Hazards	N/A
Unstable Pallet Stacks	Cartons have consistent levelling when palletised (alleviates bulging issue)
Carton Stuck in Stillages	Alleviates bulging issue
Defective Pallets	N/A
Incorrect Carton Mixes	N/A

Plate Freezers

Issues Addressed	Reasoning
Staff Shortages	Automates the freezing process. Eliminates the need for stillages and personnel loading. Promotes better working environment for operators
Personal Injury	Takes out the need to carry the work manually
Forklift Interaction	Significantly lessens forklift movements to handle this process
Carton Presentation	Overcomes the issue with carton bulging which are frequently present in blast freezers
Space Utilisation	Can fit in a lot more cartons per sqm depending on height
Carton Handling Damages	Overcomes the issue with carton bulging
Miscount of Cartons	Less variability in carton shapes. Alleviates errors when counting visually
Energy Usage	Freezing capacity is more efficient and direct on cartons itself rather than the whole room. Approx. 30% (or more) less than a blast freezer, (Condon, 2017)
Invalid Carton Labels	N/A
Organic Stains on Cartons	N/A
Slipping Hazards	No pedestrian required in plate freezing as process is automated
Unstable Pallet Stacks	Overcomes the issue with carton bulging
Carton Stuck in Stillages	Eliminates the need for stillages
Defective Pallets	N/A
Incorrect Carton Mixes	N/A

Automated Blast Freezers

Issues Addressed	Reasoning
Staff Shortages	Automates the freezing process. Eliminates the need for stillages and personnel loading the stillages. Promotes better working environment for operators.
Personal Injury	Takes out the need to carry the work manually
Forklift Interaction	Significantly lessens forklift movements to handle this process
Carton Presentation	Doesn’t overcome the bulging carton issue but there is less damage from manual handling practices
Space Utilisation	Can reduce the need for forklift paths
Carton Handling Damages	Doesn’t overcome the bulging carton issue but there is less damage from manual handling practices
Miscount of Cartons	N/A
Energy Usage	Better space efficiency on carton spatial occupation vs free space
Invalid Carton Labels	N/A
Organic Stains on Cartons	N/A
Slipping Hazards	No pedestrian required in plate freezing as process is automated
Unstable Pallet Stacks	N/A
Carton Stuck in Stillages	N/A
Defective Pallets	N/A
Incorrect Carton Mixes	N/A

Appendix 3 – Safety Hierarchy of Control (WorkSafe Victoria)

Below is a section extracted from the Safe Operation of Cold Storage Facilities Handbook completed by WorkSafe Victoria.[31] Please note that each state has a different WorkSafe body. Please contact your local WorkSafe representative for more details.

Risk management of cold stress

The Occupational Health and Safety Act 2004 requires risks to health and safety be controlled so far as is reasonably practicable. This means that employers need to identify, assess and consider risk controls which eliminate the hazard at its source as the primary form of risk control. If the hazard is unable to be eliminated, engineered out or the hazardous task, object, substance, etc. substituted with something safer then, only then, can personal protective equipment be used as a form of risk control.

Protective clothing and equipment as a risk control

Protective clothing and equipment is a common risk control for employees exposed to cold environments. However, it is not a good idea to rely solely on protective clothing and equipment to control risk as it may not properly protect all employees from risks and at the same time can create new risks and work problems.

As far as reasonably practicable, controls other than the use of protective clothing and equipment should be used to manage risks arising from exposure to cold.

Personal protective clothing and equipment should be seen as a temporary measure or a last resort to be used only when other controls may not adequately control exposure, or are not reasonably practicable.

Risks of using protective clothing and equipment

Personal protective clothing and equipment is not a good risk control because it:

- does not eliminate or reduce the risks and dangers
- may not be cost effective - often the long term monetary and employee time costs of using protective clothing and equipment are not taken into account, such as the costs of:
  - selecting
  - storing
  - cleaning
  - fitting
  - medical examinations required before use
  - purchasing
  - replacing
  - maintaining
  - training employees in use and maintenance
  - monitoring of use and extra supervision.
- only provides limited protection
- will not protect employees if it is not properly selected, fitted, used, maintained and stored
- is often less effective if more than one type of personal protective clothing and equipment is used at the same time
- is not always used when it should because it:
  - interferes with doing the job
  - causes discomfort and/or pain
  - affects vision (e.g. safety goggles, full face respirators)
  - interferes with hearing and talking (e.g. hearing protection, respirators)
  - is not used by some employees for health, physical and psychological reasons)
  - is difficult to use correctly if not properly supervised
  - interferes with employee concentration.

Protective clothing and equipment can increase manual handling risks by:

- making work harder that in turn may increase sweating and the risk of cold stress
- restricting postures and movements making the job harder to do and increasing the chance that protective clothing and equipment won't be properly used (e.g. gloves can prevent getting a good grip on tools, components and materials - this puts more physical stress on the hands, arms and shoulders).

[31] (Victoria, 2017)

Steps to follow before using protective clothing and equipment as a risk control

Step 1

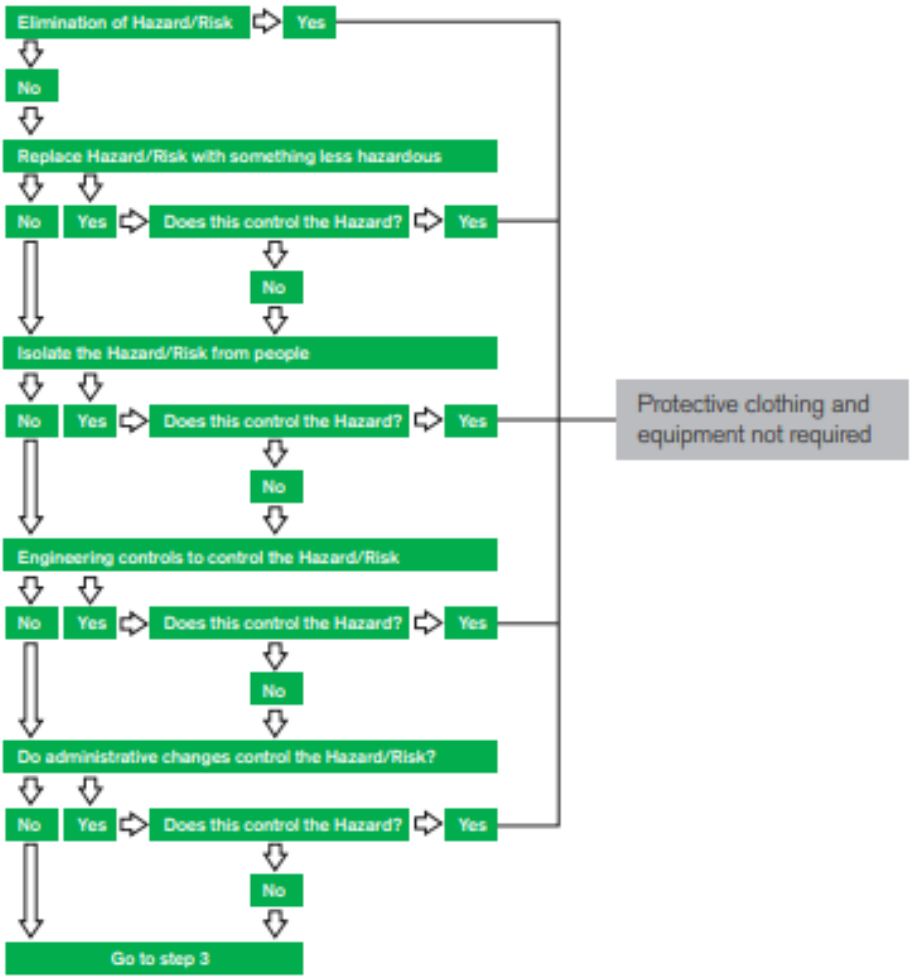
A risk assessment should be completed prior to the selection and use of any protective clothing and equipment and should be undertaken in consultation with those employees and HSRs for whom the protective clothing and equipment will be provided.

Step 2

If the risk assessment shows that risk controls are needed, the following must be considered when consulting employees and the relevant HSRs who may be exposed to cold work environments:

- eliminating exposure to cold
- isolating employees from the cold
- engineering controls that reduce employee exposure to cold
- modifying or altering the systems of work to eliminate or reduce employee exposure to cold.

If these risk controls are not reasonably practicable in the short term then appropriate protective clothing and equipment may be suitable as a temporary risk control.



(Victoria, 2017)