WORKPLACE ENGINEERING SOLUTIONS

Box 35010 – 963 Henderson Hwy
Winnipeg, MB R2K 2M0
mgordon@ehsp.ca
PH: (204) 805-0960

Research and Workplace Innovation Program
Workers Compensation Board of Manitoba
363 Broadway
Winnipeg, MB
R3C 4W3

April 30, 2022

Please find enclosed the final report detailing the project “Effective Use of the Hierarchy of Controls for Machine Safeguarding”.

The project goals were completed, and the results of this work are contained in this report. I was grateful for the chance to focus on the root causes of machine safeguarding incidents and work towards the goal of reducing them. Improving the machine safeguarding process and expanding the knowledge base for this subject in the province was an important aspect of this project.

Thank you for the opportunity to work on this project, please contact me with any questions.

Sincerely,

Mike Gordon, P. Eng.
Workplace Engineering Solutions Inc.

Effective use of the Hierarchy of Controls for Machine Safeguarding

Final Report

April 29, 2022

Acknowledgements

I would like to thank Workers Compensation Board of Manitoba for supplying the funding for this project. That funding was made possible from a grant from the Research and Workplace Innovation Program (RWIP).

I would like to thank my Industry Based Safety Program Partner Made Safe.

I would like to thank the project advisory team.

Laura Farmaner – Safe Work Manitoba

Steven Hnatishin – Made Safe

Jacquelyn Oduro – S2SA

Wayne Brylikowski – Monarch Industries

Mike McFarlane – Triple E RV

Contents

Executive Summary

The Workers Compensation Board of Manitoba, through its Research and Workplace Innovation Program (RWIP), awarded Workplace Engineering Solutions a grant for $74,290 for the project “Effective Use of the Hierarchy of Controls for Safeguarding”.

Machine Safeguarding is an area of health and safety that many organizations have trouble with. They struggle because they believe machine safeguarding is a highly technical subject area with difficult to apply tools. One of the most important tools is the Hierarchy of Controls. The Hierarchy of Controls complements the risk assessment and is a critical tool for selecting controls to protect workers at their jobs. Organizations struggle with first selecting adequate controls for the risk, and then ensuring they remain in place. This can be a conflict between motivation and ability. Companies are not lacking motivation to enact proper controls; they sometimes lack the ability, through lack of understanding of the subject matter, to correctly select and then integrate these controls.

The project sought to collect information to quantify what the reliance on the different levels of control was at organizations. With that information a further project goal was to provide resources to act on the reliance and develop tools to shift it to the higher-level controls.

It was found that organizations surveyed were 65% reliant on lower level of controls for the main point of operation interaction for workers. Tools from training videos, quizzes, audit tool and webpage were developed to work to lower that reliance.

1.0 Overview

The goal of the project was to reduce dependency on less effective controls for machinery hazards which in turn works to eliminate machine related injuries. That goal was divided into two main project objectives: a) create a baseline by collecting information in the form of audits to determine the level of reliance, then b) create tools/training to work to lower that reliance.

Machinery hazards tend to result in high severity injuries such as amputations, entanglement, and fatalities. When it comes to protecting workers from machinery hazards, many workplaces have a high dependency on controls that fall low on the hierarchy of controls such as awareness controls, administrative controls, and personal protective equipment, due to:

i. They are unaware of the differences between the types of safeguarding controls,
ii. Lack of a proper task-based risk assessment to identify hazards and qualify an adequate control, and
iii. Difficulty in design and implementation of eliminate, substitute and engineered control solutions.

CSA Standard Z432-16: Safeguarding of Machinery calls for a risk reduction strategy. The first step is inherent safe design, which is to eliminate or substitute out hazards. What often happens is that organizations start at less effective controls (like PPE or procedures) and work their way up. The less effective controls are easier to implement but require tremendous effort to sustain. Eliminating hazards or engineered controls are harder to implement but easier to sustain. The tool that summarizes this is known as the Hierarchy of Controls. As you move down from the top the controls become less effective.

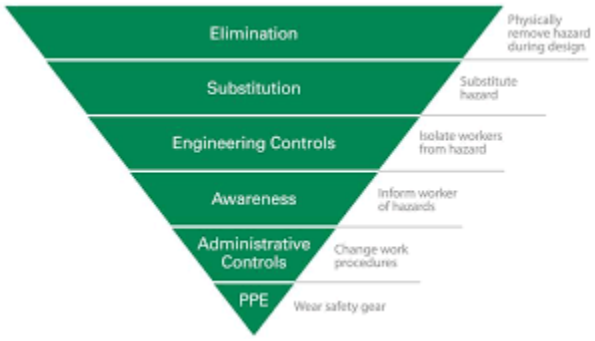


Figure 1: Hierarchy of Controls

An important note is that these lower-level controls don't indicate non-compliance. In some instances, they may be the only controls that can be implemented or could be the minimum level for compliance. Choosing the minimum level of compliance may be an indication of an organization's lack of understanding of how the higher-level controls work, thus dismissing them for feasibility. An organization who is struggling with machine safeguarding may also reach for lower-level controls as a quick fix to make progress in a machine safeguarding plan.

The project plan was to first collect information on the reliance on the different levels of controls at different organizations. That is accomplished by first creating a simple to use auditing tool for companies to determine where their dependence on controls is. The process of collecting the audit

information also serves the purpose to refine the process of auditing and highlighting the types of things we should be looking for. The areas of focus for the audit were the point of operation, third party access and the power transmission.

With the baseline information collected, the tools needed to be created to first inform organizations on their reliance at what level, and then show them how to effectively move that reliance to higher level controls. The baseline was important because before improvement can be made, its important to establish what the current state of control reliance was.

A knowledge transfer plan was developed working with our partner Made Safe. It focussed on reaching as many organizations as possible within their community with the variety of activities that they put on. A web portal used to share these results and case studies will act as a community for continued engagement. The portal was designed to allow access without any restrictions and allow the tools to be downloaded or linked for further development at the organizations. An effort was made to make all the tools open source to allow for continuous improvement of these training materials. Manitoba is home to a very diverse manufacturing sector with a variety of products and processes. Although there is an agreed best practice for the machine safeguarding process outlined in the CSA Z432-16 standard, allowing organizations to build from the tools is an important part of process improvement.

2.0 Project Work

i. **Preparation:** First an audit tool needed to be created to collect the info. A risk assessment is a complicated tool for some organizations. They can struggle with collecting the information from floor level employees because of technical terminology that is hard to understand without training. A simple tool needed to be created to collect info. The tool was designed and refined to be used with floor level workers and safety reps and supervisors. This was to take the technical aspect and make it to a more common language for the workers on the floor. The areas of concern were the point of operation, or where workers interact with the equipment. The third-party access, where other workers come into access. And the power transmission, or where the machine is powered for any moving parts. An important part of the preparation for the baseline development was determining what information needed to be collected, but more importantly how that information could be collected in a way that was useful for the participants as well.

ii. **Baseline Development:** The goal was to collect 500 audits from a variety of organizations. A focus was on Manufacturing, but Educational was another sector where data was collected to provide a comparison to manufacturing. They compliment each other as sectors because one (Educational) is supplying the other (Manufacturing) with its workforce. The organizations were chosen to create a variety of responses, so large, medium, and small were chosen, and organizations with many years of machine safeguarding experience and some just beginning their journey. Sampling was done with health and safety professionals, supervisors, and production floor employees. These audits were designed to not require a strong technical understanding of the machine safeguarding process. This was done to reach workers who may not completely understand what was at their workstation.

iii. **Audit Tool:** The audit tool was the first item created, and its use helped guide the further tools to be developed. The main purpose of the tool was to take the important information that is collected in a risk assessment and make it more transferrable to floor level employees to discuss and share information. It focussed on three areas, the point of operation, where employees interact with the equipment, third party access, which is other employees entering the area, and the power transmission, where the equipment is powered. The audit was simplified to ask employees what was the main hazard they were encountering, which could be even more simplified to what can hurt you here? It followed up any response with "is this the biggest hazard?" to ensure they hadn't just selected any hazard that had come first to mind. It also wanted them to quantify what they thought encountering that hazard did to them, or what were the consequences of contact with the hazard. With that information collected it wanted them to answer what they thought was protecting them, or what was the control. That process was repeated for third party and power transmission.

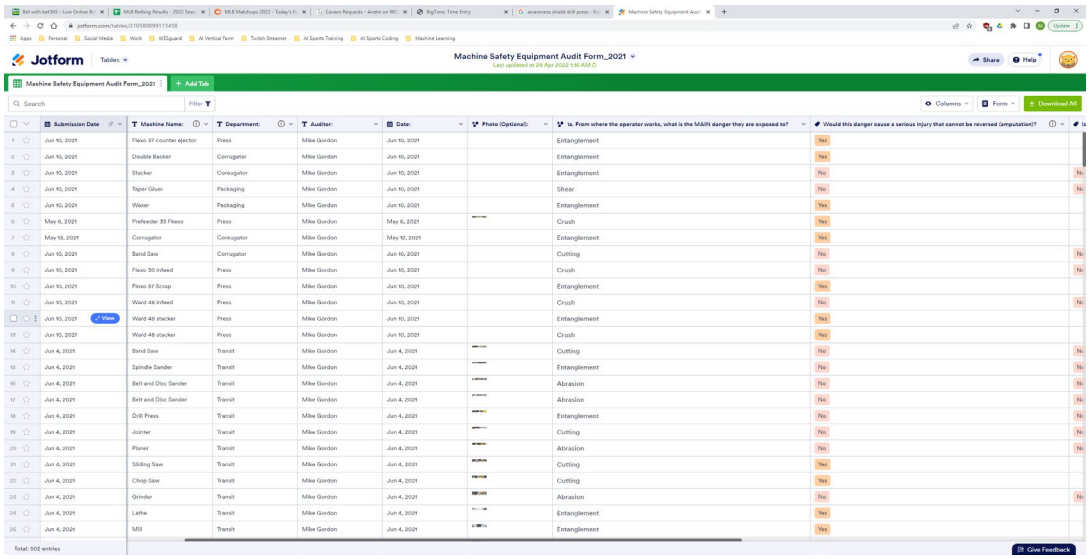


Figure 2: Collection of Audit Responses

iv. **Results:** The audits were summarized, and the level of control was compiled. The break point was Awareness controls, any controls below this were deemed lower, and Engineered Controls and up were deemed higher. This break point was chosen as engineered controls are the first level (starting from the bottom) that prevent access or stop hazardous motion if workers approach the danger area. One of the main discoveries was that many organizations believed they had high level controls in place like physical guards. What was lacking was an understanding of the different types of guards, like fixed and awareness. Fixed guards prevent all access to a hazard and are deemed engineered controls. Awareness guards prevent inadvertent access to the hazard, but don't block all access. The risk assessment can deem what is required in this situation, but it was important to question them if they understood the level of protection, where they may believe awareness are higher level controls.

Figure 3: Fixed Guard

Figure 4: Awareness Guard

v. **Reliance Level Tools:** With the audit information collected, the next project goal was to now create training and tools that can work to educate and inform the organization to move the level of reliance. The learning tools were also created to allow for transfer of knowledge. Once an understanding of the areas of concern were developed then it was critical to produce tools that could help workers. The collection of the baseline data helped frame what areas needed to be highlighted in the tools. One of the foundations was a lack of understanding of hazards and controls. The other was a lack of understanding of how the Hierarchy of Controls worked and how to correctly use it. These are both root causes to the lack of strong controls in an organization. All the tools developed worked on these two root causes.

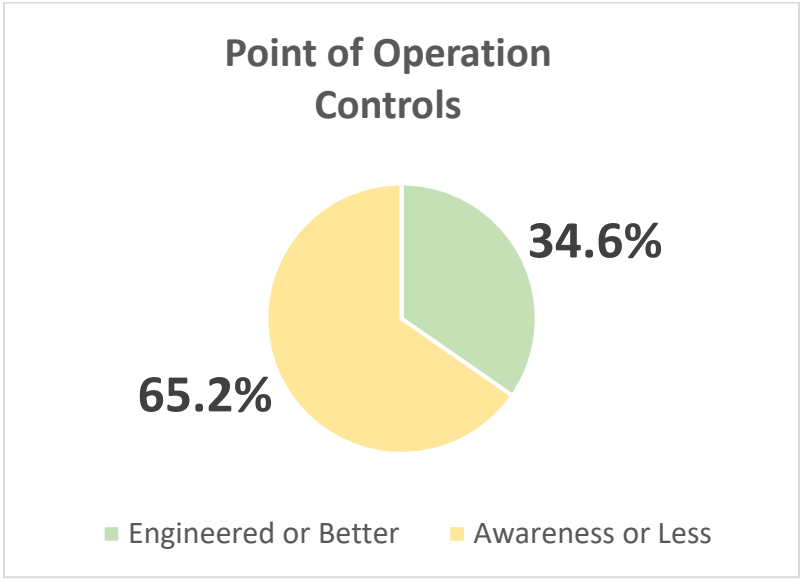


Figure 5: Overall Results Manitoba

3.0 Conclusions

The project was rewarding because of the time spent focussed with the workers that use the equipment. The approach of using an auditing tool designed for floor level supervision was also enlightening as workers and their supervisors learned a great deal by the interaction. As an engineer with many years of experience in machine safeguarding, I can acknowledge that the subject matter can be difficult to convey in an easy-to-understand method to ensure all are included in the process. At the heart of the machine safeguarding process though is a simple concept, identify hazards and work to reduce their risk. There were two main learnings that influenced the knowledge transfer and exchange presentations and the building of machine safeguarding knowledge capacity

With the collection of the baseline data, its still clear that there is a high reliance on the lower-level controls. Companies believe they have strong controls, but in auditing its clear with the shear volume of equipment and processes, there are lots of lower-level controls being used. This can be attributed to lack of understanding of controls, but also to the ease that lower-level controls can be implemented which make them attractive for organizations that are reacting to incidents instead of being proactive. Many companies are reluctant to start a machine safety program because they view it as too technical or believe that they already have controls in place to protect the workers. Often the bar is set at presence of a control for the workers, rather than the right control for the risk. An important reminder is that lower-level controls don't necessarily indicate non-compliance. This project sought to get to the root of the issue of reliance on lower-level controls and it succeeded in uncovering some of the myths of misunderstandings of the Hierarchy of Controls and the risk reduction process.

Even with higher level controls, its clear that not all workers understand what the hazards are, and importantly the highest severity hazard, and what the controls are and how they work. Controls are highly effective, but not if workers don't understand how they are protecting them. Risk cannot be zero, so some controls are very effective in their protection, but do have some limitations that need to be understood. Several times during the baseline collection process the workers struggled to identify the main hazard and were unsure of the controls that were protecting them and how they worked. This can be attributed to lack of training on hazards, and the complexity of some hazards that are not common outside of industry. High level controls are designed to protect even when multiple failure modes are achieved, but nothing is perfect, and workers knowing what the limitations of the controls are very important.

4.0 Knowledge Transfer and Exchange

The knowledge transfer and exchange plan consisted of two main objectives. Take the baseline information collected and summarize it with all the tools in a central place. Then go out an explain the results and tools to organizations.

The results and tools can all be found on an academy page that has no restrictions on access. It's designed to get someone's attention and keep them there to review the information and the tools. It consists of:

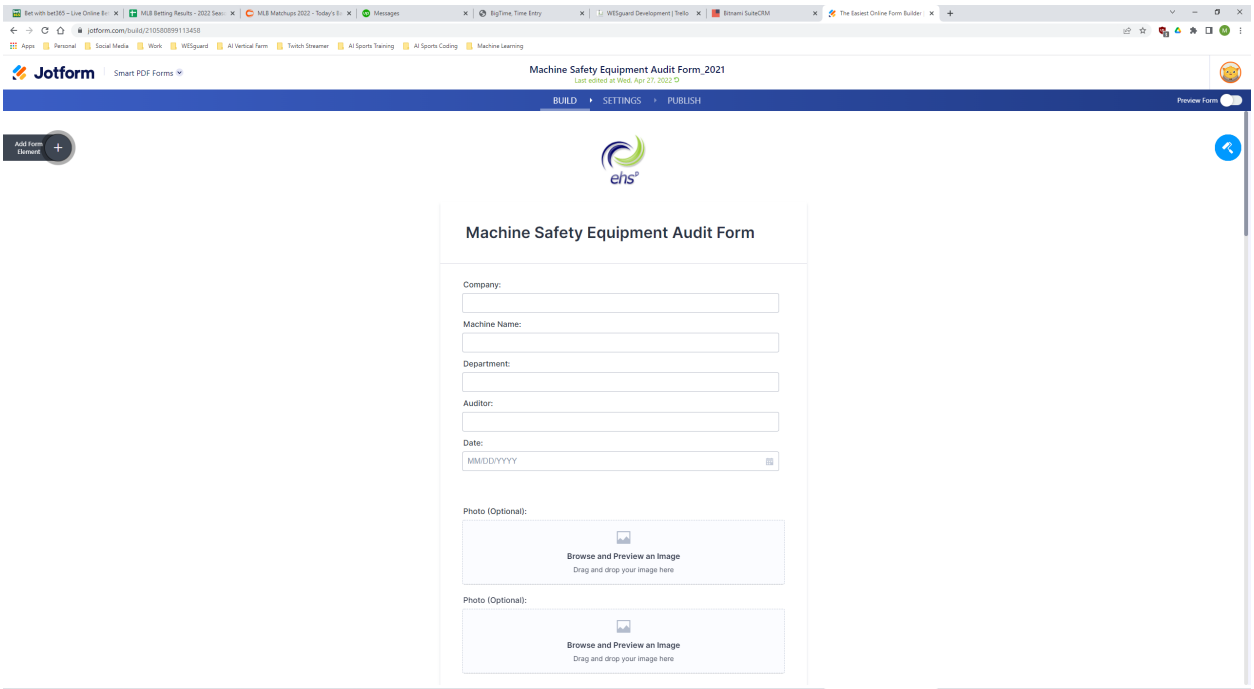
1. **Baseline Results:** It was important to publish the results from the baseline audit process. The organizations names are not revealed to protect privacy, and results are summarized based on overall size of organization. Of note is the larger the organization, the less reliant on lower-level

controls. This can be attributed to more support/resources allocated to health and safety, or perhaps the presence of technical support for implementation of controls.

2. **Industry Case Study Article:** An article was published in March 2022 in Prairie Manufacturers, a leading industry magazine for the Manufacturing Industry.
3. **Training Videos:** Videos were created to outline in a simple way the understanding of the hierarchy of controls. They are short and to the point and tell a story about machine safeguarding and the use of the Hierarchy of Controls. This facilitates them being used in training sessions.
4. **Quiz:** One important aspect of knowledge transfer is the ability to check if the concepts were understood, and gently push people back to the subject matter that may help them if they don't understand.
5. **Audit:** The audit used in the study, with the ability to download and modify for your own use. It was important to keep it in a format of open source so that it could be further developed and improved depending on an organization needs. It could have been developed as a mobile application, which had the advantages of more functionality, but limits the potential for improvement through development.
6. **Test Cases:** Examples of the correct use of the Hierarchy. For people to understand how to use the higher levels of controls, they need to see them in practice. The one strategy that is often overlooked and needs reinforcement is the elimination and substituting out of hazards.

The opportunities to explain these results were done at a variety of events. Made Safe has a quarterly forum to reach all their members in which I presented this project. Loewen Windows hosted an event where the tools could be witnessed up close. Part of the presentation was a floor exercise to see how the tools could be applied. A presentation to Safe Work and WCB is planned for the month of May.

Audit Tool



The audit tool was first developed using the free third-party software JotForm. The template can be accessed if desired through that platform. For the purposes of open source, it was also exported as a PDF that can be downloaded and modified to fit the users needs.

Complete Baseline Results

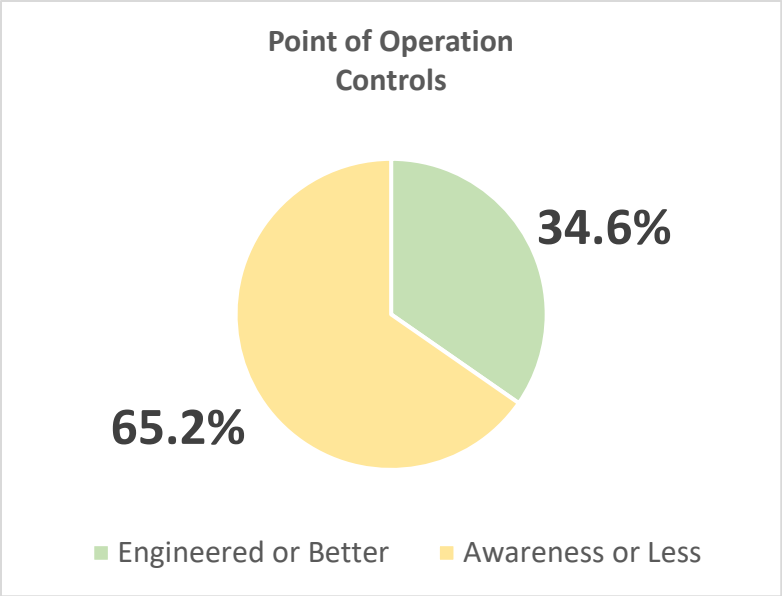


Figure 6: Overall Results Manitoba

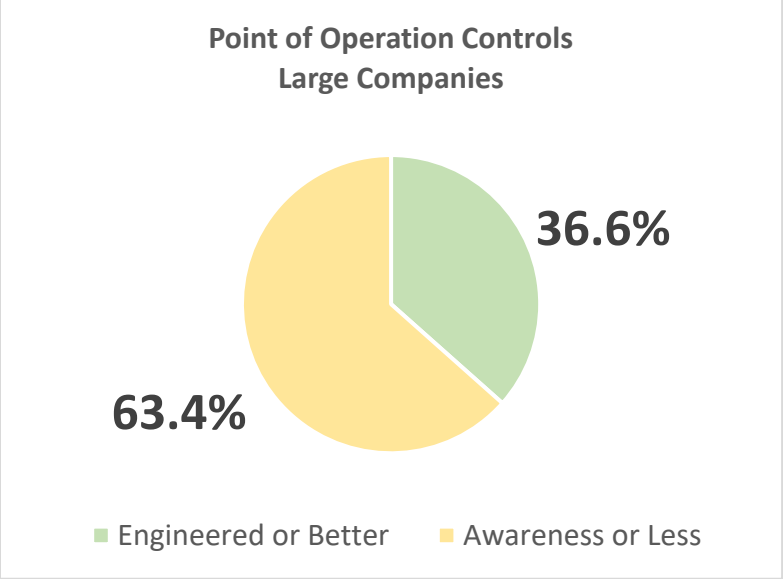


Figure 7: Overall Results Manitoba – Large Companies

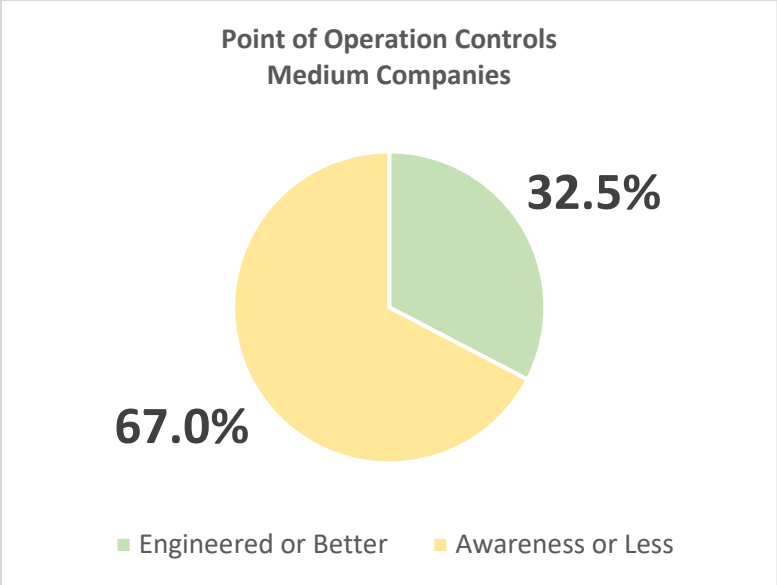


Figure 8: Overall Results Manitoba – Medium Companies

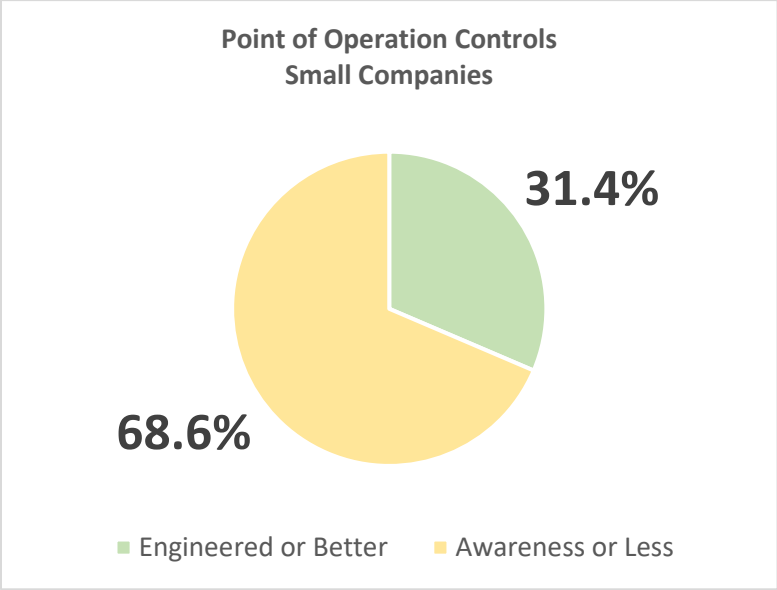


Figure 9: Overall Results Manitoba – Small Companies

Prairie Manufacturing Article

https://issuu.com/prairiemanufacturer/docs/prairie_manufacturer_-_issue_1_volume_7

Web Portal Location

https://wesguard.ca/academy.html