ALL ON GUARD – A COLLABORATIVE APPROACH TO MACHINE GUARDING AT CWTP

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Abstract

The Christchurch Wastewater Treatment Plant (CWTP) utilises a wide range of mechanical equipment as part of the treatment process. The equipment dates from the 1970s through to items installed in 2017. Driven by tightening of health and safety legislation, in 2014 Christchurch City Council commissioned CH2M Beca Ltd to complete an audit of machine guarding at the site. The audit identified equipment where guarding did not meet the new standards and recommended a range of improvements to achieve compliance. This led to an implementation phase where staged improvements to machine guarding were rolled out across the CWTP site.

This paper outlines the machine guarding audit process. It also discusses the collaborative process for engaging with the installation contractor, along with core operations and maintenance teams who were central to making the project a success.

Key lessons learned during the project include the importance of operator engagement in not just the development of guarding solutions, but to change the way equipment is operated and maintained. This can reduce the time personnel interface with machinery and has the benefit of simplifying operational and guarding requirements.

The second lesson was that that one size doesn't fit all; similar machinery could require a different guarding approach when used for different jobs or applications. Sometimes physical guarding was not practicable and it was more cost effective to replace items with new equipment. However not all new equipment is created equal and some off the shelf items can still be non-compliant.

The project emphasised the importance of working with personnel to change the mind-set from a "compliance focus" to one where "everybody wins". By working closely to get buy-in from operations staff about guarding solutions, safer ways of working can be embedded and cost-effective operations can be maintained.

Introduction

Originally built in 1962, the Christchurch Wastewater Treatment Plant (CWTP) receives and treats wastewater from the majority of Christchurch's residential suburbs and industrial areas. There are 239 pump stations located around the city which convey an average of 200,000 m^3 of wastewater to the CWTP each day for treatment. The aim of the treatment process at CWTP is to reduce solids and biochemical oxygen demand from the wastewater. The bulk liquid is processed through the plant under gravity utilising only a single pumping stage, however there are many side-line processes operating throughout the plant which involve over 500 items of machinery ranging in age up from 0 to 50 years. As a result there exists a range of machinery built to meet a range of different safety standards. With a major focus in recent years on safety in the workplace, and the introduction of the Australian machinery safety standards to New Zealand, CWTP staff realised the need for improvement on site.

Christchurch City Council (CCC) then initiated a project to bring the machine guarding at CWTP up to a compliant level. Although the project's focus was to achieve a practical compliance with guarding standards, the approach used realised many benefits to the site that weren't originally envisaged.

Site-Wide High Level Audit

The project began with a site-wide audit conducted in 2014 by CH2M Beca Ltd (Beca)

as part of work under the Continuing Services Agreement between Beca and CCC. The audit was an exercise to gain an understanding of scope and cost required to bring the guarding on site up to standard. The audit report identified non-compliance of machine guarding with current legislative requirements and produced a risk assessment matrix for the identified machine guarding hazards.

From this matrix and indicative costings for implementing safer machine guarding, the site was able to establish a prioritised programme of works. CCC decided to engage a contractor with experience in machine guarding to complete the work as a design-build project. The report produced from the high level audit was used as a scope document to form the basis of the tender documentation for the work. Through meeting and interviewing tenderers in person, CCC was able to select a contractor that was aligned with the collaborative approach intended for the project.

The Project Set-Up

After contract award, a project control team was established made up of the CWTP Maintenance Manager, CWTP Operations Manager, representatives from Mainstream Engineering Ltd (as the design/build contractor) and Beca for overall project management, coordination and design facilitation.

In addition to the project control team, to fully engage with the plant staff, specific CWTP maintenance and operations staff were assigned areas of the plant where they were the most familiar. These staff were then consulted throughout the project for the design of guarding, and approval and sign off of completed works in those areas.

An interactive collaboration spreadsheet was set up to monitor the status of the project. With live, on-line-based access, the project team was able to monitor the implementation of guarding across the CWTP site. The sheet included a line for each individual item of equipment on-site, its hazard rating and design, approval and construction status. The register made it possible to identify and group work with common guarding solutions, and to prioritise works across the site.

Site Staff's engagement throughout the project

It was acknowledged early on that to achieve successful delivery of the guarding project at CWTP, the site operations and maintenance staff had to be included in the development of the new guarding systems. Encouraging site staff input during the design phase brought a better understanding of the hazards present to both the design team, and the equipment users themselves. Understanding the risks and hazards around a piece of equipment and seeing the reasons why safety systems were being introduced helped bring end users on-board with the change in safety culture on site.

Guarding reports were produced by Mainstream Engineering for each piece of equipment or common groupings. The reports summarised the guarding deficiencies, discussed the hazards and proposed concept solutions for guards. The reports were a platform for discussion with the CWTP staff and encouraged good feedback and engagement when developing guarding solutions. The reports recorded design discussions and approvals by the CWTP maintenance and operations staff.

Allowing user-based input in the development of guarding solutions often meant that designs could be adjusted to accommodate better access systems for maintenance, avoiding the need for complete guard removal, compared with that of off-the-shelf solutions.

Sometimes physical guarding was not practicable and it was more cost effective to replace items with new equipment such as a set of forty 1950's sludge valves, actuated with exposed gears (pictured below).

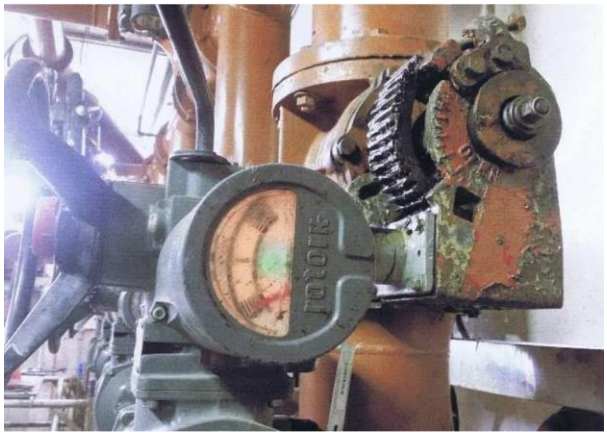

Figure 1- Sludge control valve from the 1950's

However even when new equipment was required or specified, it was found that some off the shelf items could not meet the guarding standards the CWTP was trying to achieve. In some cases, the CWTP were able to challenge this and suppliers worked with them to improve the level of guarding of their product. In other situations, where the supplier considered their item merely a component in a larger system that should be guarded, it was not possible to procure the new item adequately guarded. The awareness of what to specify and look for while procuring new equipment was an important lesson learned for all from the project.

Two case studies are described in the following sections to illustrate how the guarding process was implemented on site and some of the challenges and benefits that resulted.

Case Study 1 – Belt Presses

At the CWTP, sludge is removed from the wastewater and processed in large digesters where biogas and biosolids are produced. The biosolids are then dried before being removed from site and used on commercial land for remediation purposes. Part of this process involves two large belt presses which remove excess water from the biosolids before it is dried. These presses were installed as second-hand units in 2003, originally built in the early 1990s.

Figure 2 –Belt filter press

Each press has two perforated belts running through a series of large rollers under high tension. Biosolids are introduced between the belts, which then come together as they loop through the rollers to squeeze the water from the biosolids. Across each machine there are 20 rollers nominally 1.8m across. A pinch point zone exists on each roller capable of causing serious bodily harm. Access to the press sets is from both ground level and from a platform midway up the machine.

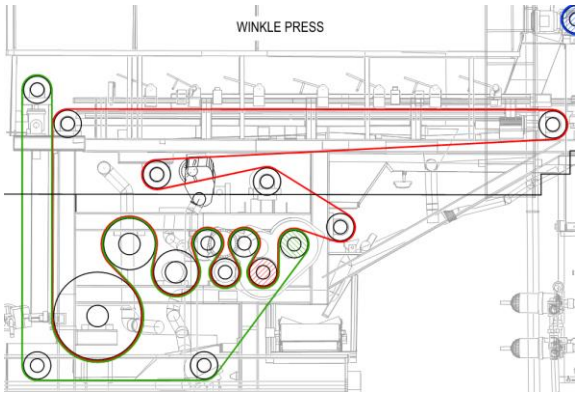

Figure 3 – Belt press rollers and belts

During the 2014 site audit, these press sets were given the highest risk hazard rating on site and were therefore the top priority item for guarding works.

A series of workshops were held with the CWTP operators and maintenance team; to initially decide on the best method of safeguarding the press sets, and then to review conceptual and detailed designs. Once a design had been agreed, the project team then planned the implementation of the guarding.

Full distance guarding was the preferred safeguarding method for the belt presses. This is when a fence type guard is placed around the equipment at a distance such that hazards cannot be physically reached. It was decided that due to the corrosive nature of the environment the guarding system would operate without any electrical equipment. This means more physical input is needed from the operators to remove or install the guarding, but the system is more straightforward to troubleshoot and implement.

The physical guarding chosen involves several sliding gates that latch together and are locked with an interlocked key exchange system. This system is widely used and operates by providing an interlock between the power to the machine and the gate locks.

Figure 4 – Guarded belt press (partial install)

It was discovered that in order to install this system, the power distribution panels for the press sets required reconfiguring to enable simple, one-point isolation for the various drives. This reconfiguration exercise (which is still being implemented) will in turn simplify the procedure needed to isolate the hazardous drives, thereby reducing the possibility of an error when performing an isolation procedure.

Understanding the operational and maintenance tasks performed around the presses was a crucial part of the guarding project. During discussions with CWTP staff, the project group learned that for one particular maintenance task - the changing of a press belt - staff needed both an operational press and close proximity access. This was a combination of requirements that had the potential to undermine the guarding approach intended as it would not be possible with full distance guarding in place.

The standards are prescriptive in that moving hazards must be isolated prior to guard removal. In most situations, site procedures make sure that this occurs; however in the case of the belt presses the guarding scheme is such that physical keys for the guards are locked away until the machine is isolated. The standards include a section that discusses situations where there is a need to overcome guarding systems to perform a necessary operational or maintenance task, and allows an alternative mode to be developed for this reason. For the belt presses a “Belt Change Mode” was agreed upon by considering the tasks and hazards at each step and determining how these could best be mitigated. The mitigation steps involved only allowing certain motors to operate in Belt Change Mode and restricting the speed of these motors to the lowest possible speed while still enabling the belt to be changed. So the mode, developed with the CWTP staff, enables access to the presses while limiting the operability of the press to the bare minimum required to perform the belt change task.

The alternative mode achieved a win for the project team – previously, during a belt change the belt speed control and start/stop were achieved using a remote computer. The remote location of the computer from the press set meant delays were introduced and miscommunications could occur between the two posts. The maintenance team were concerned with this as it meant that the machine they were working on was controlled from another room. The Belt Change Mode incorporates a plug-in pendant controller, local to the work zones with dead-man style control. The plug-in system restricts operation to a single part of the press set, reducing the likelihood of unpredicted start-ups. The final solution was a guarding and maintenance system that met the required standards, but had the flexibility to allow maintenance staff to work on the belt in the manner required but with much reduced risk compared to the previous procedures.

Case Study 2 – Older Hazardous Machines

Throughout the project, machinery requiring guarding was often old, with multiple exposed hazards. This older machinery often required significant expenditure to meet the guarding standards. Two thickened sludge pumps (TSPs) are a good example.

Installed in the mid-1990s, the pumps transfer secondary sludge across the plant. They are large capacity plunger-style positive displacement pumps with multiple exposed moving parts, similar in operation to a piston engine.

Figure 5 – Existing sludge pump, requiring guarding

Full fencing was selected as the guarding method as close-proximity guards weren't practical to install. To accommodate adequate room within the guarded area for the maintenance procedures, the designed guards had to be large and they had to be fixed in place as they were too heavy to be removable. However, by fixing in place and allowing adequate room, the thoroughfare access around and past these pumps would be severely impeded. It was decided to replace the pumps, and therefore implement a different sort of guarding.

Centrifugal pumps had been successfully used to replace similar plunger-style pumps elsewhere on site as part of equipment renewal and replacement. These centrifugal pumps are a dry-mountable submersible pump, motor-integral, with no exposed moving parts and of a size that occupies less than one third the area of the original positive displacement pump units.

A case to replace the thickened sludge pumps with the centrifugal pumps was put forward. The key advantages of this option included:

- Removing the need for costly guarding
- A large reduction in operation and maintenance costs associated with the pumps
- Consistency of pump model with other pumps on-site
- Improved thoroughfare access past the pumps

The replacement option was selected and the new pumps were installed, (see below photo). So in this case the guarding project not only lead to safety improvements, but also to improvements in operation and maintenance and long-term cost benefits to the site.

Figure 6 – Replacement sludge pump, Guarding not required

Conclusion

A 2014 high level machine guarding safety audit identified that the CWTP had a wide range of hazards on site as a result of old and unguarded machinery. By taking the initiative to implement a site wide machine guarding project, Christchurch City Council were able to not only reduce the risk of hazards on site, but they also improved the overall safety culture on site by having staff fully engaged in the project. Some of the guarding initiatives lead to simplified and safer operational and maintenance

procedures, and overall reductions in operating cost. There were challenges along the way – not all new machinery is supplied fully guarded so even where old equipment is replaced with new, moving machinery hazards can still exist. In other cases, it was necessary to allow access to moving machinery as part of maintenance activities and so simple guarding methods were not workable. As the project team worked through each item in a collaborative manner, better understanding of work procedures was gained and final solutions that were practical but compliant were achieved.

Keywords

Machine guarding, health and safety, collaboration, compliance, Christchurch, wastewater, machinery

Figure 7 – Before guarding

Figure 8 – After guarding