

# **Safety Improvement through Training Using Incident Reports**

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## **Abstract**

Despite the implementation of training during the onboarding process, weekly safety training, and on the job training a contractor experienced a disturbing trend in incidents reported during the 2022 work season. To understand the details surrounding and attributing to these incidents' general safety data from the past five years was collected for analysis. An in-depth analysis of the 2022 safety data was also generated from a series of incident reports. These reports contain both quantitative and qualitative data. The information provided in this paper covers both the general data collected and a detailed analysis of the 2022 reports. Based on the information collected program improvements are provided. Improvement to both the safety and the training program is necessary and a marriage of the two will be critical moving forward. These improvement suggestions are presented through refined training program proposals, technology incorporation examples, and include incentives for safe work. The improvements have not been adopted but are in the process of proposal. To ensure a safe completion to the 2023 work season several goals based on the information are generated.

## **Keywords**

General Incidents, Screened Incidents, Backing Incidents, Safety, Training, Quick Response Code (QR Code)

## **1. Introduction**

Training with the contractor, specifically safety training starts with the employee onboarding process and continues during employment. Annual safety meetings, on the job training, and toolbox talks are examples of the continuous training. Specific training is provided by the company in areas such as traffic control, driving, and equipment operation. Traffic control training may focus on state or municipality requirements for a safe work zone. Driver training revolves around safe driving, pre/post trip inspections, and compliance with federal and state regulations for both CDL and non CDL company vehicles and equipment. Equipment operation training is primarily conducted with an on-the-job training method, but manufacturer training sessions for specific equipment are also utilized. These trainings are documented via the employee's records. If the training involves official certification such as First Aid/CPR the certificate is stored in the employee's personnel file. Other training specific to the company such as equipment operation competencies is recorded in a master sheet and is updated as employees perform on the job duties.

This paper will examine the safety data from the contractor from the last 5 years. The paper will specifically examine how safety and incident data can be utilized to identify trends and determine training priorities. Furthermore, how can a trained workforce reduce incidents. Based on the data suggestions for improvement will be discussed examples of resources presented. The program improvement data will be generated using quantitative and qualitative statistical analysis harvested from incident reports. These reports contain objective information such as dates and times but also include individual accounts and recollections of specific incidents. The reports and information will be utilized to determine trends and target employees for training. Finally, a realistic set of improvement goals and how to meet these goals with proper training will be generated based on the information contained in the report. Safety will be accomplished through training.

### **1.1. Objective**

During the 2022 construction season the contractor experienced safety incidents resulting in serious injuries, property damage, and lost time claims. To objectively understand the safety incidents and identify areas of improvement current documents, practices, and data must be objectively analyzed. This paper will review the current safety and training plans utilized by the contractor and examine the employee and incident data. Variables observed in the data will be presented as focal points for program improvement.

The objective of the review is to examine the current safety plan standards, reporting, and incidents. This paper will be specifically focused on the incident report data. The current safety and compliance plan at the contractor is molded by the OSHA regulations put forth by OSHA 1910 Occupational Safety and Health Standards which are general set of standards that create an umbrella over all industries (OSHA, 2023). More specifically the program focuses on OSHA 1926 Safety and Health Regulations for Construction (OSHA, 2023). The program also follows the standards outlined in OSHA 1904, Recording and Reporting Occupational Injuries and Illnesses, to report, post, and communicate workplace injuries to all parties (OSHA, 2023). The current safety plan utilizes incident report forms to track and collect information regarding specific incidents. Incident investigations are conducted for each incident reported.

## **2. Literature Review**

Training is the most important part of safety. According to Polmear and Simmons (2022), “training is crucial to help workers identify and manage hazards, reduce risky behaviors, and develop safe practices” (p. 365). Safety starts with training and safety is accomplished through training. Research suggests that a safe environment is also a more productive environment with less employee turn over (Cheng et al., 2015). For this environment to exist there must be a clear universal qualifications system in place that focuses on training individuals starting with the onboarding process and continuing with ongoing annual training opportunities. Studies show that long term continued learning is one of the key factors linked to retention of safety training (Hashem, et al., 2021). The qualifications system would ensure employees are professionally trained for their job duties resulting in the safe completion of the job with improved performance (Cheng et al., 2015). Ultimately safety is achieved through training.

Training systems such as described could also create a level of accountability for employee groups based on a set of standards. Standards based evaluation would one way to evaluate the safety and training of an employee. Cheng (2006) suggests more emphasis could be placed on evaluating the performance of employees in the construction industry. Prior to evaluating there must be systems and frameworks in place to guide the evaluations.

One of these systems which would promote a safe culture and workplace is a safety incentive program. There must be some incentives provided to employees that follow policies, utilize SOPs, and embrace a safety-first mindset, but keep in mind incentives will vary depending on company characteristics (Dolan, 2008). Research suggests that safety incentive programs reduce accidents by 75% if deployed properly (Yeow & Goomas, 2014). Different generic incentive-based programs are utilized in various industries from manufacturing to retail and might include earning points for days worked without incidents, honoring an employee of the month who demonstrates safe practices, or even rewarding employees with incentives such as paid time off or gift cards.

These strategies focus on reinforcing the positive behaviors. Studies also suggest that when behaviors are collective among groups of employees, they influence new employee’s behaviors (Olson et al., 2009). For instance, in the study conducted by Olson et al. they found that if groups of employees utilized appropriate PPE it would impact other employees in a positive way (2009). Rewarding and reinforcing are positive tools, but there must be clear procedures in place that outline proper behavior as well.

Standard operating procedures and incident reports can be converted to digital using technology for broader utilization. Qiu and Li (2023) provide evidence that these documents contain pivotal information that can be utilized in risk prevention. Technology also plays a broader role in safety regarding virtual and training. A recent study suggest virtual reality can be utilized to assess an employee’s safety performance without accepting the risk of injury (Han et al., 2021). Although the cost of some of these systems is intimidating there are systems in place that are low-cost relative to other options (Phillips, 1998). For example, creating a video to train employees has an upfront cost associated, but once produced can be utilized countless times. Furthermore, according to Trust et al. this technology infused type of instruction and education has a positive impact on the training process (2021). For this reason, companies are adopting training and programming that relies on technology. According to Pace (2013) almost one in five companies were rapidly increasing their utilization of technology in training. Additionally, almost two-thirds

were steadily increasing (Pace, 2013). Over the course of the last ten years technology has continued to play a pivotal role in training.

### **3. Methods**

The current safety data was collected using a general incident database containing incidents spanning the last five years. The general incident database is a master list containing general information about incidents. The data was first collected and sorted by year. Once the data was sorted by year it was arranged by location. This data is collected and sorted by weekly reports which are organized by date. It is important to consider that this information contains only reported data. There are both near miss situations and incidents that go without reporting each year.

Step 1: General Incident Examination: Examine data collected by contractor for incidents over the past five years. This is surface level information with general details associated with the information such as date of occurrence and type of incident.

Step 2: Screen Individual Incident Reports: Transfer information from individual incident reports from the last year for analysis. Determine if incident involved bodily harm, equipment damage or property damage and remove the reports if they do not meet the stated criteria. Sort all incidents related to backing up.

Step 3: Examine Specific Incident Variables: Collect both qualitative accounts of incidents from employee statements and quantitative measures such as time, day of week, and employee information. This employee information includes information such as duration of employment. Other variables include day of week, hours on duty, and vehicle type. Examine both the general and specific data to identify trends.

Step 4: Propose Solutions: Utilize the information collected to guide decisions for safety and training programming. Provide examples of proposed solutions.

### **4. Data Collection**

The general incident data for the past five years was collected and examined first. The general incident data was the focal point of analysis, but other factors were explored as well. These factors include total number of employees, duration of employment and total hours worked for seasons.

The data for incidents from 2022 was then sorted and reviewed. The information harvested from the incident reports for 2022 will be utilized as descriptive statistics. For example, the general statistics in the Figure 1-10 below indicate there were seventy-six recorded incidents in 2022. However, upon the completion of reviewing the incident reports sixty-eight total reports provided detailed information on incidents involving employee injury, equipment damage, or property damage. Deer hits and third-party incidents not involving employee injury or property damage were excluded. For example, an incident report from 2022 included a detailed description of a third-party confrontation with a flagger, was not included.

To better understand contributing factors and identify areas of focus for training the backing incident data from 2022 was collected from incident reports. Backing incidents were identified as a primary focus of this study. There was a total of twenty-seven backing incidents during the 2022 season. This sample can be compared with the total incident statistics from 2022. The first set of information examined pertaining to backing will focus on hours on duty. Specific factors such as hours worked, day of the week, and employment duration will be utilized to identify areas of focus and examine incident trends.

### **5. Results and Discussion**

The total number of recorded incidents from 2018-2022 is displayed below. This is general incident data and includes 3<sup>rd</sup> party reports and deer hits. This chart tracks all reported incidents for the last five work years(2018-2022). After 2019 the contractor saw a steep decline in reported incidents. Although in 2022 the total recorded incidents nearly doubled. Examining the variables and information from the 2022 incidents will be critical to changing the current incident trajectory.



Figure 1. Reported Incidents 2018-2022

The chart below displays the sum of all employees and the sum of all reported incidents from 2018 through 2022. It is important to note that although the total number of employees declines across the five year time period the incidents increase in both 2019 and 2022. Sorting and examining individual incident data will allow for a more descriptive interpretation of the information provided below. To determine trends in overall incidents variables such as hours on duty, weekday, hours worked, and years employed by the company were examined for the 2022 incidents. This information will allow for the development of a baseline data which can be utilized to determine characteristics of the incidents and guide training efforts.

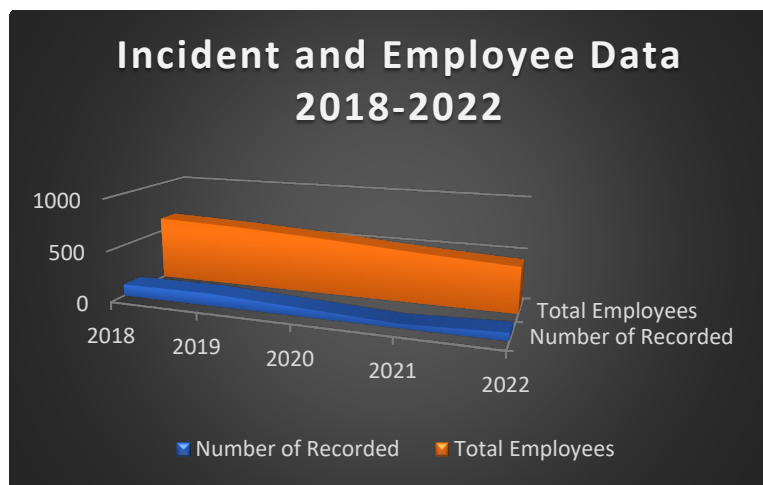


Figure 2. Incident and Employee Data 2018-2022

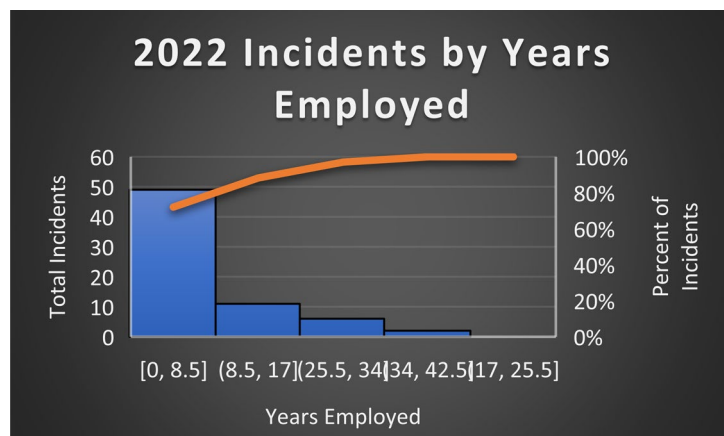


Figure 3. 2022 Incidents by Years Employed

When examining the data from 2022 one specific variable of focus was total years employed. The Pareto chart above shows the data of all incidents in 2022 accounting for the number of years employees involved in the incidents worked for the company. In 2022 there were a total of sixty-eight reported incidents, of which forty-nine incidents involved employees who had not yet completed eight and a half years of employment in the company. This employee group (0-8.5 years employed) accounted for 72% of incidents. There was a drastic decline with the next largest group (8.5-17 years) in which eleven individuals accounted for (16%) of the incidents in 2022. The remaining eight incidents (11.7%) involved employees who were employed for more than seventeen years. This information can be analyzed like the measurement of a defect. The above pareto chart suggests this data follows the 80-20 rule, which is 80% of the defects or in this case incidents are accounted for by employees with less than 8.5 years of experience while the remaining 20 percent of incidents were linked to employees with over 8.5 years of experience.

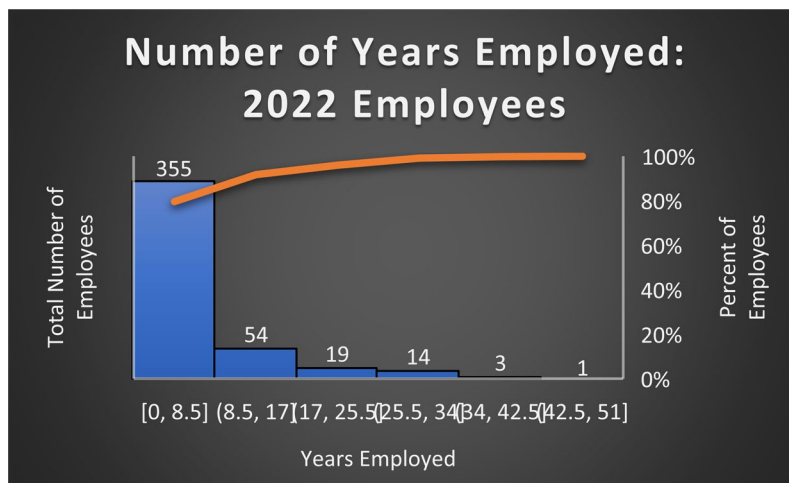


Figure 4. Number of Years Employed: 2022 Employees

Above is a Pareto chart for 2022 which indicates the total number of employees by years employed. This histogram closely aligns with the incident histogram. However, there is useful information that helps target a population with risk for more incidents. Employees in with 8.5 years of experience or less accounted for 76.1% of the all the employees but accounted for 72% of incidents. Individuals employed for 8.5-17 years made up 11.5% of employees in 2022 but accounted for 16% of the incidents. This information serves as a process to check and track employees by number of years worked and identify trends to determine which groups account for more incidents or disproportionately account for incidents. Examining or revisiting training methods for the 8.5-17-year group of employees along with initial training practices of all employees could improve this data.

Viewing all the variables as they pertain to incidents during 2022 produces some information to use as a baseline for characterizing the general incident patterns. The first piece of data is that the incident numbers are trending upward. The total completed incident reports were up 80.9% for 2022 when compared to 2021 although the number of employees is trending down (-9.7%). When considering incidents in 2022 by location to extract patterns total hours worked was also examined and despite working less hours overall (-3.4%) when compared to 2021, incidents increased. The other variables deal with time. Employees who worked for the company for less than 8.5 years accounted for nearly three quarters of the incidents. When considering the data presented, employee groups or locations who account for a smaller percentage of the population but record a larger percentage of incidents should be flagged for tracking purposes. Locations are not included for anonymity purposes. This could indicate unsafe practices. On the other hand, employee groups or locations that account for an incident percentage that is smaller than the population group represented should be examined for best practices. This could indicate safe practices.

### 5.1 Screened Incidents Including Backing

The chart below compares when incidents and backing incidents occurred during the duty day. There was a total of sixty-eight incident reports completed. Information regarding specific time was found on fifty-five of the reports. Twenty-seven backing incidents were reported. Specific times were only provided for twenty of the backing incidents. Due to the fact backing incidents with time stamps totaled 20 there were thirty-five remaining(non-backing) incidents with time stamps. As the charts shows 80% of the backing incidents with times reported occurred from hours 3-12. Furthermore, 30% occurred during the 9–12-hour period which is three times the amount when compared to other recorded incidents (10%). This information reflects only the backing incidents (20) and other incidents (35) with times reported.

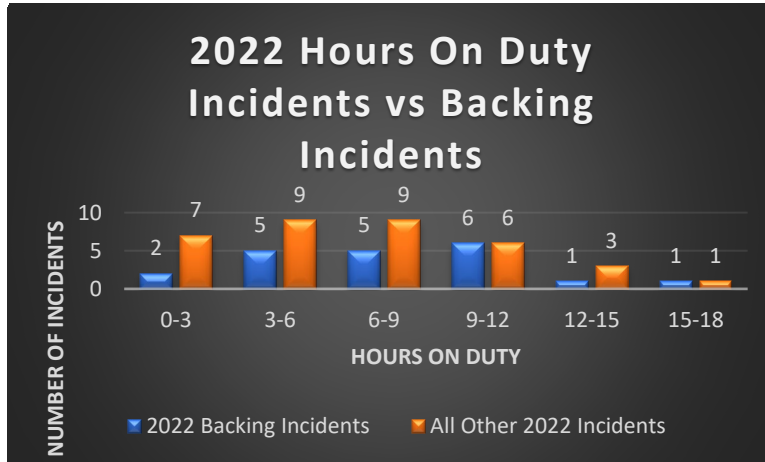


Figure 5. 2022 Hours On Duty: Incidents vs. Backing Incidents

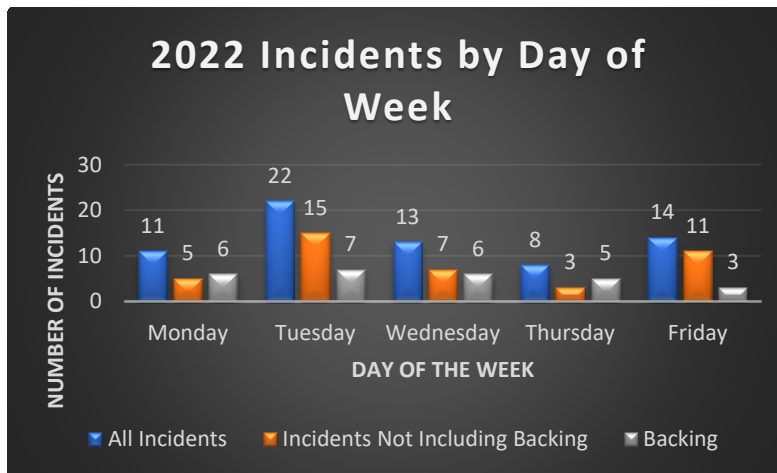


Figure 6. 2022 Incidents by Day of Week

The chart above identifies when incidents occurred by day of the week. When examining backing incidents by weekday seven (the highest number) of the twenty-seven incidents occurred on Tuesday and three incidents (lowest) occurred on Friday. Tuesday was the day of the week in 2022 in which the most overall incident and backing incidents occurred. Monday also was a common day for backing incidents with the total number of backing incidents occurring on Monday (6) outnumbering the other incidents (5). Thursday is also worth examining as a baseline with eight overall incidents taking place, five of the eight were backing related and three others.



Figure 7. 2022 Incidents and Years Employed

The chart above displays the breakdown of incidents reported in 2022 arranged by years employed. Employees with less than 8.5 years of experience had highest incident reporting for backing (74%) and other incidents (70%) and make up over 75% of the work force. Employees who have completed 8.5-17 years of employment accounted for 11% of the backing incidents, 16% of the overall incidents, and represented 11.5% of the 2022 employee population. Individuals with 25-42 years of employment were responsible for 14.8% of the backing incidents, 11% of the overall incidents, but only make up 4% of the workers.

After reviewing the information on backing incidents in 2022 several distinct contributing factors can be identified. Employee length of employment at the company and other factors can be used help determine a target employee group to implement detailed training. Although individuals with 25 or more years of experience make up a minor portion of the population, they accounted for almost four times their population in recorded backing incidents. Tuesday remains the highest recorded day for both backing and other incidents. However, Mondays and Thursdays had more backing incidents reported than normal incidents. This indicates training and processes should be examined and revised.

## 5.2 Proposed Improvements

Based on the data presented it is evident there are several areas for improvement pertaining to safety. Almost 40% of the incidents involved backing and this area has been identified as a point of emphasis. Upon the conclusion of the 2022 season over one hundred cameras had been installed. Supporting materials such as standard operating procedures for common company equipment and tasks will be presented. An incentive program for safety moving forward will also be presented. In the following section improvements related to training will be discussed.

To improve the safety of employees standard operating procedures can be utilized to prevent incidents and develop a trained workforce. Common operations in the company that are linked to incidents such as backing up could be standardized using a companywide standard operating procedure (SOP). An example of a SOP is linked below that specifically covers backing up. The proposed SOP would be categorized under the title of Safe Work Practice which would be a series of SOPs surrounding common tasks and the safe completion of those tasks. The SOP is purposefully created from a user point of view and clearly defines the task. Clearly defining the steps of the task will hinder deviation from the SOP and result in a uniform outcome. The outcome of the backing SOP is the safe and successful completion of backing up a piece of equipment. Part of developing these procedures allows for a logical sequence of events to take place such as the initiative First Move Forward. If an individual can move forward and prevent the task of backing up completely, they should utilize this action. However, in the event the equipment cannot be moved forward the SOP will serve as a checklist to safely back up the equipment.

### Example of Improvements



Figure 8: Improvement Examples

Utilize a safety incentive program to promote safety. The proposed incentive program in this paper utilizes strategies that are molded off reinforcing positive behaviors rather than penalizing negative behaviors. With that said, if safety infractions occur the employee still must be held accountable. This program does focus on the positives, but it also will hold individuals accountable. A detailed description of the program can be found below, and example flyer is linked above.

Three different tiered incentives are utilized. The top incentive is an end of season drawing for a grand prize which will be companywide, a drawing at mid-season (July 4<sup>th</sup>) for an extra day of paid time off (PTO), and a monthly gift card drawing for each location. The mid-season PTO drawing will be based on an 8-hour workday and drawn for every fifty employees at a location. Locations with less than 50 employees will be entered in the drawing pool with larger locations.

In addition to the drawings, the employees selected randomly each month with no safety infractions will be featured in a safety spotlight. The safety spotlight will be located on the company bulletin board near the schedule. The poster will identify the individual who won the drawing that month and highlight their contributions to a safe work environment. To be eligible for the drawings employees must not have any driving or safety infractions observed by the DOT or the field safety representatives. These infractions will be noted on DOT scale inspections and/or the work cite safety checklist utilized by operations and safety personnel. Incident reports should not be used as criteria as it may deter individuals from reporting incident. Employees must be with the company for 90 days to qualify for the mid-season and end of season drawings. Records will be maintained by the safety and compliance department.

Deploy a training program will improve safety. As part of the improvement plan the company could create a complete overlap of the safety and training department. The Venn diagram below describes the historical state of safety and training and indicates the current state of safety and training at the contractor. The future state of safety and training would be a complete overlap of the two. There are areas of emphasis that can help facilitate a change in training, so training not only promotes a skilled qualified work force, but also embraces a culture of safety.

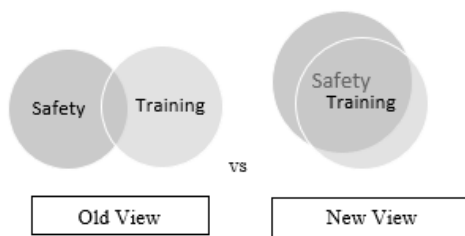


Figure 9. Training Incorporation



Employees would be trained using a standards-based model. For the model to work standards for various components of the job would need to be developed. These standards could focus on different areas such as the yard, various divisions, and recognize certifications. For this example, we will focus on a set of standards for an entry level laborer. The proposed standards for general level laborer are listed below.

#### Contractor Standards for General Level Labor (CS GLL) Example

1. CS GLL 1 Entry Level Laborer
  - 1.1 Employee understands the basic safety and traffic control procedures related to asphalt crack repair such as flagger communication, signing, and work zone safety.
  - 1.2 Employees understand job specific PPE and recognize silica hazards.
  - 1.3 Employee demonstrates ability to remove debris from the work zone utilizing various methods such as a blower, air wand, or broom.
  - 1.4 The employee can operate basic equipment.
2. CS GLL 2 Basic Laborer/Driver
  - 2.1 The employee possesses a class D driver's license, Fed Med Card and maintains a defensive driving record.
  - 2.2 The employee displays proper pre trip and post trip inspection procedures.
  - 2.3 The employee exhibits proper utilization of the tablet and paper logs.
  - 2.4 The employee displays collaboration and communication skills.
3. CS GLL 3 Advance Laborer
  - 3.1 The employee demonstrates appropriate operation and maintenance of advanced equipment.
  - 3.2 The employee illustrates appropriate operation specialty equipment.
  - 3.3 The employee effectively communicates safety hazards and equipment discrepancies with supervisors.
4. CS GLL 4 CDL Driver/Lead
  - 4.1 Employees possess valid Class A CDL license and demonstrate safe driving procedures/record.
  - 4.2 The employee understands load requirements and weight distribution for equipment.
  - 4.3 The employee understands material quantity measurements and inventory/supply procedures.
  - 4.4 The employee demonstrates proper trouble shooting and maintenance of equipment.
  - 4.5 The employee demonstrates leadership skills that exhibit effective communication, inclusion, and quality.

The system would rate employees on four levels. To be considered for another level employees would demonstrate competencies in the previous level. Studies show that practical application (demonstration) of skills related to safety is the strongest way for employees to retain the skills (Hashem, et al., 2021). Quantitative values could also be assigned to the standards such as a certain number of hours driving or operating equipment. Forepersons or training leads could record and document accomplished standards upon completion of the work week. These levels are described below. This system could track employee qualifications based on standards set forth by the company. The standards and qualifications could be tracked for each employee.

Level 1: Meets Standards CS GLL 1; 1.1-1.3

Level 2: Meets Standards CS GLL 2; 2.1-2.4

Level 3: Meets Standards CS GLL 3; 3.1-3.5

Level 4: Meets Standards CS GLL 4; 4.1-4.5

In addition to ensuring proper training of employees to promote the safe execution of a task these levels could also aid in scheduling and could be utilized as part of a performance/employee review matrix. Standards for the various work divisions could be developed along with a matrix which also accounts for length of employment.

Data collection serves as one of the areas with the most room for growth. As indicated in both the general incident data, screened incident data, and backing incident data there are some holes in the information that was collected. Two standards can be implemented to ensure complete and accurate documentation of incidents, job site visits, and training. The first standard relates to accountability. There are several systems in place to collect the data such as incident forms, job site checklists, and training logs. However, all these systems of data collection are invalid unless they are utilized. Managers must be held accountable for quick and accurate data collection regarding incidents, job site visits, and training. With the proper tools this can be accomplished. Standardized electronic forms which are discussed in detail below are one option for data collection. The example below focuses on a jobsite checklist, but this same format could be used for incident reporting and training logs. Second, data must be sorted and analyzed.

Data should not be collected and looked at after the fact, it should be utilized as an ongoing continuous improvement process that can chart and track improvement or hazards as the construction season continues. Creating a standard that pertains to analyzing data on a daily or weekly basis would allow for these improvements to occur.

### **5.3 Technology Based Solutions**

To roll out the training and safety plans described in this paper technology must be utilized. Electronic standardized job site checklists, standard operating procedure videos, and arial load placement and weight distribution charts are just a few examples of how technology could be utilized to improve safety and training. Electronic job site safety checklists such as the example discussed would contain all the information included on a paper version of the job site checklist. An electronic checklist would allow the evaluator to enter observations electronically in a survey fashion. Once the information is input it could be stored in a spread sheet for accurate efficient analysis of both safety and training data. For security purposes not all information can be collected and recorded electronically, but general job site information such as proper utilization of PPE, SOPs, and traffic control could easily be recorded with a date and time stamp. This could save hours of data transfer and streamline the process.

Part of streamlining processes includes the utilization of videos SOPs. Both safety and training procedures can be delivered in video form. Utilizing videos for safety and training allows for a dynamic training opportunity. Videos can be utilized and accessed by anyone in the company at any time, they allow for direct instruction when a trainer is not present, and they break down language barriers and promote diversity and inclusion using graphics and subtitles. This reinforces the company's dedication to being an EOO. Below is an example of a video that focuses on how to pair a backup camera. This video can be accessed via QR code and provides a brief yet concise training on how to pair the camera system. This video was produced using the Adobe Creative suite which could be purchased by company for less than one hundred dollars per month. The ability to create videos that are vital to a common process will provide education and efficiency to any standard operating procedure.

Additional opportunities for implementing technology includes electronic weight distribution charts for vehicles. Utilizing electronic weight and distribution charts could expedite the loading process, eliminate overweight tickets, and create a uniform process for loading vehicles company wide. If this system were implemented an employee could simply scan a QR or locate a database via an app on their drivers tablet which would display the load information. This information could include tank charts or birds eye views of the deck with object placement. Establishing a database to track the load distribution of each vehicle would provide employees the information necessary to never overload a vehicle. These databases and charts would establish a level of accountability for the driver to conform to legal weight policies. If equipment is transferred to another location, this data base could serve as an anchor for consistency pertaining to load placement.

#### **Technology Driven Safety and Training**



Figure 10. Technology Driven Safety and Training QR Codes

### **6. Conclusion**

Based on the document above safety and training implementation goals for the 2023 season are necessary. These goals must be integrated into one goal: safety through training. Goals focusing on backing up incident reduction and goals focused on how to train employees to meet these reduction goals are vital. These goals should be lofty and are necessary, but also need to be realistic. Proper training of employees on the implementation and utilization of back up cameras and standard operating procedures will reduce the incident rate. A critical evaluation of the proposed

safety incentive program and qualification program will be completed by the mid-way point of the 2023 season with implementation forecasts.

It is also important to note that missing information for specific variables such as time worked could obscure the efforts to track patterns and identify potential safety risks for employees. Implementing a goal to collect 100% of the data related to incidents is a critical to accurately assessing the safety and training program at the conclusion of the 2023 season.

Finally, to effectively reach all employees a pilot to diversify training will be implemented in 2023. This pilot will utilize the QR and electronic form technology described above to streamline a uniform training platform with equitable access for all employees. This type of training will ensure the safety of all employees.

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## Biographies

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