WHO IS BETTER AT IDENTIFYING AT-RISK BEHAVIOR? LEADER VERSUS EMPLOYEE PROCESSES TO IMPLEMENT TASK-SPECIFIC BEHAVIORAL PINPOINTS

A Thesis
by
MATTHEW M. LASKE

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Abstract

WHO IS BETTER AT IDENTIFYING AT-RISK BEHAVIOR? LEADER VERSUS EMPLOYEE PROCESSES TO IMPLEMENT TASK-SPECIFIC BEHAVIORAL PINPOINTS

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Reducing workplace injuries through preventative measures requires the identification of risks so that interventions can be designed to reduce the prevalence of behaviors that may result in injury. Behavioral safety processes have been adopted by numerous companies to achieve this goal. A multiple-baseline design was used to examine the effects of implementing a task-specific checklist on the identification of risk in an existing behavioral safety program at a Fortune-500 chemical manufacturer. The pinpointing of task behaviors was performed either by managers or employee focus groups to see the impact on risk identification. The employee pinpointing process resulted in more behavioral pinpoints, whereas the manager driven process included more conditions, knowledge and awareness questions. The employee driven process demonstrated the greatest increases in risk identified when the task-specific checklist was put into use by the workforce. The management pinpointing process was associated with minimal increases in risks identified. The employee driven process also resulted in the creation of the most preventative safety action items than their manager counterparts. Overall, the study found preliminary evidence

that employee driven pinpoints are more likely to conform to behavioral criteria, identify more risk, and lead to more safety action items when compared to manager processes.

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First, a “thank you” does not capture my gratitude and appreciation of my committee chair and mentor, Dr. Tim Ludwig. Thank you for supporting me in taking on a thesis of this scope and for your guidance in the development of my writing. You have provided me with countless opportunities that went above and beyond what I anticipated, but for brevity of writing, I will not list them here. I appreciate all the time and effort you have dedicated to shaping me as a professional, presenter, academic, and researcher. I look forward to our next venture.

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To my parents, Mike and Veronica, thank you for your unconditional support throughout all of my life's ventures and understanding throughout my academic endeavors. None of this would have been possible without your support. To my non-biological brother, Josey, thank you for being a constant source of humor to distract me when needed. Lastly, I dedicate my thesis to my younger brother, Mitch. Thank you for being my best friend throughout my life. Love you, brother.

This project involved, 5,802 behavioral observations, 4,317 lines of code, 300 employee interviews, 236 episodes of F.R.I.E.N.D.S. to re-watch, 232 observation questions, 90 weeks of data collection, six research assistants, five departments, and two external databases. Yet none of it would have been possible without my one partner, Maira. Thank you for your continuous and selfless support. To you, partner.

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Foreword

This thesis is written in accordance with the style of the *Publication Manual of the American Psychological Association (6^{th} Edition)* as required by the Department of Psychology at Appalachian State University

Who is better at identifying at-risk behavior? Leader versus employee processes to implement task-specific behavioral pinpoints

Matthew M. Laske

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Who is Better at Identifying At-Risk Behavior?

Leader Versus Employee Processes to Implement Task-Specific Behavioral Pinpoints

There are approximately 2.8 million annual injuries and illnesses within the United States private work sector resulting in 882,730 days away from work (Bureau of Labor Statistics [BLS], 2018a) and over 5,000 fatalities (BLS, 2018b). Because the number of injuries and fatalities remain high, intervening to prevent workplace incidents is of social importance.

Workplace incidents can also be costly for organizations. In 2017, the estimated cost of workplace injuries were $165.5 billion, which included wage and productivity costs, medical and administrative expenses, and damages (National Safety Council, 2019). On average, a medically consulted injury costs companies $39,000 and a fatality costs $1.15 million (National Safety Council, 2019). Injuries can also result in employees spending time away from work, often referred to as days lost. In 2017, total days lost were estimated at 104 trillion days, 67 percent of which occurred due to injuries in 2017, and 33 percent were the result of injuries from previous years (National Safety Council, 2019). These statistics illustrate that organizations have both a moral and business interest in investing in efforts to improve their workplace safety.

Traditional safety practices are often driven predominantly by antecedent tactics and involve rules, policies, signs, and training programs to increase knowledge and awareness. Consequence tactics such as incentives are also common and can include programs with group and individual rewards for obtaining a goal of zero incidents for a set period. Although well-intended, these incentives can result in underreporting of risk and injuries (Pransky, Snyder, Dembe, & Himmelstein, 1999). Punishment is often used to discourage unsafe actions. Similar to incentives, this often results in decreases of reporting, especially when the punishment can result in termination, such as in a three strike system (Guo, Goh, & Le Xin Wong, 2018).

Despite these limitations, safety management systems have contributed to the reduction of workplace incidents. Injuries have been trending downward since 1992, with an injury rate of 8.9 per 100-full time employees, compared to 2.6 in 2017 (BLS, 2018a). Although injuries and illnesses rates have decreased significantly over the last 25 years, the number of fatalities have remained more or less constant, with 6,217 in 1992 and 5,147 in 2017 (BLS, 2018b; see Figure 1). Due to this stagnation in the number of fatalities, safety experts (McSween & Moran, 2017) have asserted the need for processes designed specifically to reduce these serious injuries and fatalities (SIFs).

Behavioral Safety

An empirically demonstrated method for reducing workplace incidents is the application of behavior analytic principles to safety (i.e., behavioral safety; Grindle, Dickinson, & Boettcher, 2000; Sulzer-Azaroff & Austin, 2000). behavioral safety is a process of (a) identifying behaviors most critical to safety, (b) behaviorally defining those measures for precision and reliability, (c) observing critical behaviors, (d) providing feedback on safe behavior after observation, and (e) reinforcing progress towards goals.

A meta-analytic review of behavioral safety found that 32 of the 33 reviewed studies demonstrated a reduction in injuries (Sulzer-Azaroff & Austin, 2000). Another review demonstrated decreases in incident rates across fifteen behavioral safety programs accredited by an objective team of expert reviewers (Cambridge Center for Behavioral Studies [CCBS], 2020). A recent application of behavioral safety (Myers, McSween, Medina, Rost, & Alvero, 2010) demonstrated an 81% decrease in recordable incidents and 79% decrease in lost-time incidents over a 20 year span.

Although behavioral safety is a well-established process with over 40 years of successful implementation, it too has failed, along with many other safety initiates, to impact serious injuries and fatalities at a necessary level. McSween & Moran (2017) suggested that for behavioral safety to contribute to the reduction of serious injuries and fatalities (SIFs) it must (a) identify high-risk tasks, (b) clearly define the behaviors within those specific tasks, and (c) identify the behavior and environmental precursors around the high-risk task for intervention design. The assertions made by McSween and Moran (2017) indicate that if higher-risk tasks are targeted for behavioral observation, greater identification of risk can be achieved in activities that could result in SIFs.

Wirth and Sigurdsson proposed a similar recommendation calling for further study in the application of behavioral safety to reduce SIFs asking "are general classes of behavior appropriate targets for intervention?" Their call for research centered around whether behavioral observation checklists should pinpoint task-specific or general response classes of behavior. (Wirth & Sigurdsson, 2008, p. 592). These discussions emphasize the need to differentiate between general checklists that list response classes of behavior (e.g., body position, housekeeping, and PPE) versus task-specific behavior that is much more pinpointed to movements (e.g., "cut away from body with your thumb on the back of the blade"). The research question is if task-specific behavioral checklists go further than general behavioral checklists in the identification of higher risk targets that reduce the potential for SIFs.

General versus Specific Observation Checklists

Researchers have used a variety of different behavioral pinpoints in published studies. In the two original behavioral safety publications, Komaki, Barwick, and Scott (1978) used task-specific pinpointed behaviors (e.g., "when lifting or lowering dough trough, hand holds and at no time loses contact with dump chain") whereas Sulzer-Azaroff & De Santamaria (1980) used general conditions that were as a result of behavior for a checklist (e.g., "obstruction of exits", "hazardous material storage"). Fellner and Sulzer-Azaroff (1984) utilized a combination of general (e.g., "hardhats are to be worn while in the yard") and task-specific pinpoints (e.g., "hoists are used when lifting a roll of paper onto the machine; the sling of the hoist should be wrapped around the roll"). A further example of these differences in critical pinpoints can also be found in a study by Lebbon, Sigurdsson, & Austin (2012), who demonstrated differences in critical pinpoints by targeting a general condition of trip hazards with a general description of "no congested walkways" and more specific task behaviors around potential burn incidents. The latter pinpoints included specific descriptions around cooking tasks such as "stands back when opening combi-ovens" and "rotary oven: OFF" (Lebbon et al., 2012).

Although 40 years of behavioral safety applications have consistently been associated with increases in safe behaviors and the reduction in injuries (Cooper, 2009; Krause, Seymour, & Sloat, 1999), no interpretations were provided regarding the relative effectiveness of general or specific pinpoints. Killimett (1991) described situations in which a general behavior pinpoint should be used versus a specific behavioral pinpoint. Generic behavioral pinpoints are not specific to any job and include targets such as equipment condition and personal protective equipment (PPE) use (Killimett, 1991), whereas critical behavioral pinpoints are job specific and should include tasks that are likely more hazardous. Killimett (1991) illustrates this difference with an example of an employee lighting a furnace. Behaviors within this task are more crucial because the hazard associated with it is more dangerous (i.e. potential fatality).

If the observation is based on general pinpoints, the resulting data and feedback to employees may not be representative of tasks performed. In the example of Lebbon et al., (2012), trip hazards were a condition resulting from worker behavior. If workers receive feedback on this unsafe condition, but their behavior didn't cause the condition, avoidance behaviors may be reinforced whereas volunteering in the observation process may be punished.

Another common difference between general and specific checklists is the rotation of checklist items. Programs using specific checklists tend to rotate items as interventions and feedback raise safety performance of behaviors above criteria. These behaviors are replaced by new pinpoints (Cooper, 2006). The rotation of pinpoints allows for revaluation of critical behaviors that have been mastered by the workers for replacement with pinpoints that may still be at-risk (CCBS, 2017). In contrast, pinpoints on a general checklist typically remain indefinitely regardless of safety performance, work design changes, or technological changes. This is due to the general categories where some specific safe behaviors may be mastered within the response class (e.g., shoveling with a wide foot stance within body position) whereas other behaviors within the same response class may still be at-risk (e.g., bending at waist while shoveling).

Behavioral Pinpoint Criteria for Task-Specific Checklists

Just giving more detail on a task-specific checklist does not lead to a more discriminate behavioral pinpoint. Behavioral pinpoints must provide detail about the behaviors involved in tasks instead of just providing more detail around the product of behavior (e.g., work conditions clean, using proper tool, wearing PPE, completed permit). A more task-specific item may state "safe lifting technique used while moving oil drums." Although this is more specific to the task, there is not enough information on the topography of the behavior to evaluate what "safe lifting technique" means. A pinpoint similar to this is too ambiguous and may not orient the observer to the behavior needed to be observed. Therefore, criteria for specific pinpoints need to be developed and tested.

Johnston and Pennypacker (1980) adopted Skinner's definition of behavior to:

> The behavior of an organism is that portion of the organism's interaction with its environment that is characterized by detectable displacement in space through time of some part of the organism and that results in a measurable change in at least one aspect of the environment. (p. 48)

Johnston and Pennypackers' (1980) definition of behavior was expanded to adopt seven-pinpoint criteria. The pinpoint should indicate (a) the bodily (or verbal) action that should happen, (b) the physical thing in the environment the behavior is impacting, (c) when the behavior should occur, (d) what the behavior will achieve. Furthermore, the pinpoint must be (e) observable and measurable, (f) under the employee's control, and (g) passes the dead-person test.

Bodily or verbal action that should happen. Johnston and Pennypackers' (1980) definition of behavior focuses on movement of the organism and excludes states. Defining behavior as physical movements of the body (both physical and verbal) has been discussed elsewhere (Mayer, Sulzer-Azaroff, & Wallace, 2019; Miller, 2006; White, 1971). Mayer et al. (2019) further describe what is meant by excluding states, "Behavior implies action. So labels, states, or personal characteristics like happy, sad, and alert are not included" (p.22).

Physical thing in the environment the behavior is impacting. Johnston and Pennypackers' (1980) definition of behavior also included the interaction the behavior has on the environment. The authors elaborate on this stating, "Behavior cannot occur in an environmental void, nor can it occur in the absence of living tissue. Furthermore, it happens only when an interactive condition exists as a result of some relational state" (Johnston & Pennypacker, 1980,

p. 49). Behavior must not only be an active physical movement but it must also result in some change in the environment.

When the behavior should occur. Mayer, Sulzer-Azaroff, and Wallace (2019) describe pinpoints as requiring behavioral objectives. A critical aspect of the objective is the context of the behavior. Context can be defined as, “conditions under which the desired response is to occur” (Mayer et al., 2019, p. 75). Kazdin (1994) described context as the antecedent stimuli that specifies the conditions in which the behavior is to occur. In behavioral safety, context is important as it specifies under what conditions a specific behavior is required for a safe outcome. For example, an electrician must place their hands in a fuse box to complete work. If the electrician places their hands in the fuse box prior to turning off the power it could result in an electrical shock. Therefore, specifying that the electrician should work in the fuse box after the power has been turned off will result in a safe outcome.

What the behavior will achieve. A behavioral pinpoint should also include what the behavior achieves in the process (i.e., the behaviors function). Mayer et al. (2019) also recommend that behavioral research should focus on, “actions (both physical and verbal), and the functions of those actions” (p. 22). Miller (2006) also includes what the behavior achieves or avoids in the definition of behavior, stating, “Behavior is physical, and it functions to do something” (p.15). In behavioral safety, a pinpoint should describe the consequences of the behavior regarding what it achieves or avoids. An example would be, “put on gloves prior to touching equipment to avoid excessive heat.” This pinpoint describes what the behavior would function to achieve (avoiding the heat). Another example to demonstrate a pinpoint achieving an outcome is, “grab a stepladder to reach equipment.”

Observable and measurable. The essential requirement of behavioral pinpoint in behavioral safety is that in can be observed and measured (Sulzer-Azaroff & Austin, 2000; Sulzer-Azaroff & Fellner, 1984). Chance (2006) includes observation and measurement in his definition of behavior, “Behavior may be defined as anything an organism does that can be measured” (p. 37). Other authors have included observation requirements as a test of whether the behavior is a physical movement, “The best test of whether it is physical is whether you can observe it” (Miller, 2006, p. 15). In stating the behavior must be detectable so it can be measured, Johnston and Pennypacker (1980) explain that it “means perceivable; if it happens, that is ultimately knowable by an observer” (p. 50).

Under the employee’s control. Pinpointing behaviors and conditions that are within the employees have been emphasized since the earliest applications in behavioral safety (Sulzer-Azaroff & Fellner, 1984). By pinpointing behaviors in the employees control it allows for appropriate delivery of consequences for employee behavior (Daniels & Bailey, 2014).

Passes the dead-person test. Lindsley (1991) proposed that to ease the use of behavioral principles for practitioners (i.e., parents, teachers, etc.) behavior analysts should have plain English translations. An applicable test to determine if a measure is behavioral is the dead-person test (Lindsley, 1991). The test simply asks, “If a dead man can do it, it isn’t behavior and shouldn’t be taught” (Lindsley, 1991, p. 457). The dead-person test assists novice practitioners with determining if a pinpoint contains movement of the body and is observable.

The goal of the present study was to determine the pinpointing process more likely to produce checklist items targeting behaviors as defined by the definition of behavior (Johnston & Pennypacker, 1980) and the expanded seven-pinpoint criteria. We believe that accurate behavioral pinpoints will result higher risk identification when workers use the checklist during observations done within their behavioral safety program.

At-Risk Identification

A goal in behavioral safety is to identify risk when and where it is happening in the workplace. Employee behaviors can put them at risk. Therefore, finding these behavioral risks allows for efficacious interventions to be implemented to prevent injury. Indeed, the use of general versus specific pinpoints may impact the quality of the behavioral safety process itself.

General checklists could create ambiguity in the observation process. A general pinpoint such as “Hands free from pinch points” might result in differing opinions from the observer and the worker over what constitutes a correct demonstration of this behavior. This could result in the observation being marked as safe opposed to at-risk to avoid potential confrontation with the worker who might disagree. This negative reinforcement could result in the observer marking items as safe more often (Matey, Gravina, Rajagopal, & Betz, 2019). These issues of interpretation may detract from the effectiveness of feedback and eventually harm a behavioral safety process as participation is punished and “all safe” responses on checklists are negatively reinforced.

General pinpoints also may result in low identification of risk because ambiguous pinpoints can easily be interpreted as safe because of their lack of operational definition. For example, the general pinpoint “hazard/pinch point,” can make ratings difficult when workers are asked to differentiate between a safe and at-risk response. A general pinpoint is not a sufficient antecedent to evoke any particular identification of risk as it does not identify the temporal moment of when a behavior becomes at risk of a pinch point. A specific behavioral pinpoint can identify the temporal moment the behavior may put workers at-risk (e.g., “while loosening bolts on equipment, start from the back side to avoid unintended movement of equipment"). Because this pinpoint specifies the temporal moments and topography of the behavior it is more likely function as a discriminative stimulus for the observer watching this particular risk.

For example, falling objects could potentially harm an employee stationed below, so a worker being able to identify the specific at-risk behavior becomes crucial to intervening. A general checklist may use items such as "free from line of fire" as a pinpoint during the observation. An employee conducting the observation may score these items as safe during the observation due to the vagueness of the risk they are trying to identify. For line of fire, where exactly is the employee at risk of falling objects? What's the safe alternative? A specific checklist designed around the behavioral criterion would identify more pinpointed behavior to keep the worker safe during the specific high-risk task. Example of pinpoints are "look up to verify no work being done above" and "put out barriers when work is performed above the area." The resulting observation would allow an employee to better discriminate between at-risk and safe behavior in the high-hazard task as well as provide more useful feedback to their co-worker.

When at-risk behaviors are identified successfully, we are more likely to see the variance in performance that are likely to result in injury. Sometimes this variance is latent and can be missed using general checklists. Shortcuts, for example, result when an employee engages in behavior that make a process quicker or less strenuous and can often put an employee at risk. These deviations are naturally reinforced by the reduction in effort needed to complete a task. An employee could take a shortcut by using an improvised tool instead of the engineered tool. If the improvised tool requires less effort, using it will be reinforced.

When deviation in work processes occur, targeted behavioral observations should identify this variance and provide critical information for the analysis and mitigation of contingencies influencing risky behavior. A general checklist may not capture this deviance whereas a specific checklist pinpointing "employee uses engineered tool while cleaning machine" would. The data around the employees' deviation from the engineered tool would provide behavioral information helpful in the analysis of contingencies controlling the employees use of the improvised tool. The resulting contingency analysis may indicate that the improvised tool was longer in size than the engineered tool allowing for more leverage.

Contingency analysis that lead to effective intervention design, therefore, are reliant on the identification of risk in individual checklists and the trending of behavioral variance as checklists are gathered and analyzed. Behavioral safety processes that fail to identify risk cause range restriction in the observation data. Range restriction occurs when the standard deviation of the behavioral data is so small that most of the data falls within a narrow range of the scale. Range restriction occurs in behavioral safety when observers are lenient and rate all pinpoints on a checklist as "all safe" consistently across observations. Results of data analysis then suggest that nearly 100% of the time behaviors are safe. When this happens it gives us the misconception that there are no at-risk behaviors to target. Behavioral safety processes need to find variance that include at-risk behaviors to identify and mitigate the events that result in injury.

Analyses of at-risk behavior are conducted on behaviors with the most variance (low safe percentages), however, if there is no variance in the data due to range restriction, analyses may be completed on behaviors that are not truly deviant (near 100% safe) or neglected altogether. Further, if there is no variation in observation data, the ability to evaluate the effectiveness of interventions is limited. Finally, restriction of range resulting from a leniency effect (i.e., "all safe") may indicate to management that the workers are performing their tasks safety. However, when incidents occur related to behaviors rated "all safe" management may infer the process to be ineffective.

A general checklist may be more likely to produce range restriction whereas a specific checklist may result in more variance. In data reported by the CCBS from 2009-2015, a grocery distribution facility utilized a general checklist for its behavioral safety program. The data found that Personal Protective Equipment (PPE) use was consistently safe over 18 consecutive weeks resulting in a restriction of range in their data, minimizing their ability to identify risk. Due to the organization's stagnant, albeit safe, performance around PPE it was removed from the checklist to pinpoint more specific tasks/behaviors that were critical to the employees' safety (CCBS, 2017). This resulted in pinpoints (e.g., "stop vehicle, look, and beep horn when approaching intersection") that identified more risk and minimized the restriction of range evident before in the general pinpoint. Cooper (2006) demonstrated similar results in which selecting new, specific items every 4-5 months resulted in increased risk identification. It is hypothesized that more specific behavioral pinpoints used for observation will result in increased risk identified.

Manager vs. Employee Pinpointing of Behavior

Another variable that may affect risk identification is the subject matter experts who determine the pinpoints for behavioral observation. Historical safety data (e.g., injuries and close calls) and interviews with managers and employees are the first step in identifying pinpoints for observation and analysis (Wilder, Lipschultz, King, Driscoll, & Sigurdsson, 2018). Typically, a group process is then used to nominate and prioritize pinpoints for inclusion on behavioral observation checklists.

Behavioral safety programs have utilized both employees and managers for pinpointing critical behaviors within the group process (Myers et al., 2010; Sulzer-Azaroff, Loafman, Merante, & Hlavacek, 1990). Cooper (2006) used volunteer employee work groups to develop pinpoints from the incident data. These employees then conducted functional analyses to determine the contingencies controlling the behaviors. These lists of behaviors were then discussed among employee workgroups to determine a final list of 20 pinpointed behaviors for observation. The author found a 45% reduction in the total number of injuries from baseline to intervention, demonstrating the success of employee driven pinpointed behaviors.

In contrast, Reber and Wallin (1984) developed pinpoints with only front line supervisors. These efforts resulted in approximately 35% reduction of total incidents. Myers et al. (2010) utilized a mixed group of employees and managers for the development of a critical behavior checklist. There intervention was successful in reducing OSHA recordable rates from an average of 4.14 during baseline to 0.79 during the behavioral process.

Copeland, Ludwig, Bergman, and Acikgoz (2018) conducted a focus group meeting where employees were asked to identify behaviors for self-observation and feedback. Three of their six pinpoints were empirically related to the desired outcome (sales). During the duration of the study, management introduced four new behaviors, only one of which was shown to be relevant to the outcome. Results indicate that employees are excellent subject matter experts for identification of behaviors that are crucial to their performance, perhaps better than management.

The behavioral safety literature recommends that employees drive pinpointing in behavioral safety programs (Bumstead & Boyce, 2005; Depasquale & Geller, 1999; Krause et al., 1999; Ludwig & Geller, 1997; McSween, 2003). An employee-designed checklist may be more likely to identify risk because the items can be generated from their direct experiences. For example, employees in a pinpointing meeting would reflect on their current work conditions and what is hazardous to their job, and a management meeting would be driven by referring to written policies and procedures for the design of safety pinpoints (McSween, 2003).

The perception that one can get punished or get someone else in trouble for identifying risk may lead to employees only identifying safe practices in the observation checklist, resulting in leniency and range restriction. The expectation of punishment may be diminished in an employee pinpointing process as items selected are areas that employees are seeking to identify and mitigate risk to keep one another safe, making the observation process more reinforcing (Bumstead & Boyce, 2005). In a management driven process, the items may be designed to control safety behaviors and be developed into policy. Designing pinpoints around rules and policies may not capture the variance in behavior that employees could identify. The management process may also lead to perceptions that negative consequences will occur for the identification of risk (McSween, 2003).

There has been no investigation into whether employees or managers create more critical pinpoints that better identify risk. It is anticipated that employee specific checklists will conform to behavioral criteria and identify more risk than management driven checklists.

Current Study

The current study focuses on investigating which behavioral safety processes are most effective at finding variance/at-risk behavior. Differences between the amount of variance around risks identified and level of risk identified in general versus specific pinpoints were compared. Critical behaviors developed by management and employees were also compared for identification of risk.

This study examined the effects of employee and management identified specific pinpoints for observation checklists at a chemical manufacturing plant. A division within the plant had a long-standing behavioral safety process that used management-driven general behavioral categories for the checklists. In this study, these general checklists were revised to create task-specific checklists. Two departments developed their checklist through management participation while one other department developed through employee participation. Two other departments were used as control groups that made no changes to the general checklist.

Departments in which employees led the pinpointing were expected to select pinpoints that better conform to behavioral criteria on critical tasks. Additionally, employee pinpointing is expected to produce a higher number of at-risk behavior when employees engage in the observation process within behavioral safety.

An exploratory variable explored as part of the study were management initiatives (i.e., “action items”) attempting to mitigate potential for injury were collected. Action items can be created after lagging indicators, (e.g., injuries, worksite audits, and equipment failures) occur. Action items also can be created leading indicators such as behavioral observations which lead to preventative interventions before an incident occurs. Differences in action items created from leading and lagging indicators were explored post-hoc.

Methods

Participants and Setting

The industry partner in this study was a Fortune 500 chemical manufacturing plant of approximately 8,000 employees who allowed access to five departments involved in the manufacturing of various polymers sold to other businesses for use in the production of consumer goods and maintenance of equipment. The plant was in operation seven days a week and 24 hours a day. Team managers and worker crews would work alternating schedules, rotating between four consecutive day shifts, three consecutive night shifts, three consecutive day shifts, and four consecutive night shifts. The order of these shifts vary across four different crews.

Three experimental departments (i.e., Departments A, B, & C) transitioned from a general to a specific checklist through group processes involving either managers or employees. These three experimental departments were selected by the division leadership for intervention due to an increase in recent injuries. Two additional comparison departments (i.e., Departments D & E) did not engage in any changes to their existing behavioral safety process and were used as controls.

Department A had approximately 39 workers, 2 team managers, a safety coordinator, maintenance coordinator, and a senior administrative assistant. Department A's critical tasks were (a) set up and operation of heavy machinery, (b) utilizing industrial lift cranes to move materials and equipment, (c) cleaning and repair of industrial values, and (d) align and secure holding fixtures, cutting tools, attachments, accessories, or materials onto machines. Hazards, behavioral risks, and potential injuries within these tasks include (a) potential impact with moving machine and/or parts while operating machine (b) potential impact/crushing while moving materials/equipment with crane, (c) exposure to material and abrasions to eyes and face while cleaning valves (d) housekeeping hazards around leftover product materials (slips, trips, cuts, etc.).

Department B had approximately 28 workers, one team manager, a safety coordinator, maintenance coordinator, and a scheduling planner. Department B's critical tasks were (a) cleaning industrial equipment with high pressure water (3,000-10,000 psi), (b) cleaning production piping, (c) movement and maintenance of hydro blasting equipment, and (d) coordinating job site reviews with production prior to cleaning. Hazards, behavioral risks, and potential injuries within these tasks include (a) slips, trips, falls, and cuts associated with increased water on jobsite (b) damaged hosing exposing high pressure water to employee, (c) risk of lacerations (d) opening of equipment not scheduled for cleaning and exposure to chemicals, and (e) exposure to material and abrasions to eyes and face while cleaning equipment.

Department C had approximately 40 workers, 4 team managers, a safety coordinator, maintenance coordinator, and an engineering staff. Department C's critical tasks were (a) collecting samples of product materials, (b) switching out pump drains, (c) blowing out lines, and (d) rodding dumpsters. Hazards, behavioral risks, and potential injuries within this task include (a) strains around arm, leg, and body positioning to collect samples, (b) being exposed to chemicals released upon opening valve, (c) strains around back and arms while loosening bolts on pump drain, (d) being exposed to built-up chemical pressure while removing pump, (e) being exposed to leftover chemical buildup while cleaning a line with hand tool, and (d) being exposed to chemical compound upon breaking up material with a rod.

Department D had approximately 41 workers, 4 team managers, a safety coordinator, maintenance coordinator, and an engineering staff. Department E had approximately 40 workers, 4 team managers, a safety coordinator, maintenance coordinator, and engineering staff. Department D and Es' critical task were (a) collecting samples of product materials, (b) switching out pump drains, (c) emptying excess materials stored in buggy with forklift, and (d) moving raw and finished materials with forklifts. Hazards, behavioral risks, and potential injuries within this task include (a) strains around arm, leg, and body positioning to collect samples, (b) being exposed to chemicals released upon opening valve, (c) strains around back and arms while loosening bolts on pump drain, (d) being exposed to built-up chemical pressure while removing pump, (e) potential impact/crushing while working around forklift and buggy, and (d) being exposed to chemical materials while maneuvering buggy.

A nondisclosure agreement between the host organization and the researchers is included in Appendix A. This agreement outlines the use of nonidentifiable data from the host organization. The host University Internal Review Board (IRB) also approved the use of this data (IRB# 20-0051, Appendix B).

Baseline Behavior-Based Safety Process

The host organization had implemented a Behavior Based-Safety (BBS) system approximately fifteen years prior to the intervention. Training videos and an observation checklist were purchased from a consulting vendor and used for new employees but had not been adapted to specific differences across departments.

The BBS checklist contained 37 generic items that were not specific to any department. Instead, the checklist contained general categories descriptive of behavioral response classes (i.e., the product of many behaviors). Examples of items include, “hearing protection”, “eyes on path”, “hurrying/rushing”, and “struck by objects.”

Managers and workers conducted observations by going out in the field and finding another worker, contractor, or maintenance employee to observe. There was no requirement to bring a paper version of the checklist into the plant for use in observations and personnel seldom used that option. Observers would then provide feedback to the employee based on their recollection of items from the observation checklist.

The information from the observation would be entered in the electronic data system which contained the checklist. A worker was provided the option to select “safe”, “at-risk”, or “not observed” for each of the items on the checklist. A quota was in place for most workers to complete a specified number of observations in a month. Departments A and B did not have a quota, Department C had a quota of six, and Departments D and E had a quota of five. Leadership in Department C decided to decrease the quota from six observations per month to one observation at the launch of the task-specific checklist. Towards the end of the month, a worker would receive an email reminder if they had not yet met the quota.

A monthly safety meeting was held, during which workers were shown data around the most frequent occurring at-risk items and discussed ways to improve performance around the risk. No goals were set around the improvement of pinpoints and no attention was provided to previously made improvement around pinpoints.

Research Design

A multiple baseline (ABC) within (General to Specific Task-based checklist) and between (Manager vs. Employee Pinpointing) design (Cooper, Heron, & Heward, 2007) was utilized across five departments of a manufacturing company, staggering the implementation of a specific checklist across experimental departments. Each department employed a general checklist during the Baseline Phase. Towards the end of Baseline (A) the participating department was told that changes would be made to the checklist (A'). Then designated participants engaged in the pinpointing of critical task-specific behaviors and the development of the checklist (B). Finally, after checklists were published, the new checklist replaced the baseline checklist (C) for ongoing behavioral observations.

The between-subjects comparison was made between departments where pinpointing was done by department leadership, team managers, and safety coordinators (i.e., Departments A and B) versus departments where pinpointing was done by workers within the department (i.e., Department C). Departments D and E remained in baseline (A) over the duration of the study. A summary of the process timeline for each department can be found in Table 1.

Intervention

Introduction Meeting (A'). A meeting was held with department leadership and the safety coordinator to discuss the purpose of the project. Those in the meeting were told that the observation process was being redesigned to identify critical tasks and behaviors that are most important employee safety.

Pinpointing (B). Available safety data from the prior three years were reviewed to identify patterns to determine what behaviors, environmental conditions, resulted in or were related to incidents and near misses specific to each department. Critical tasks that workers completed that resulted in an injury or a near miss were compiled based on their frequency and severity.

A meeting was held to identify critical tasks and pinpoint behaviors for the development of the new task-specific checklist. The pinpoints were designed around high-hazard tasks required of workers in the department. In department A, attendees of the pinpointing meeting were department leadership, team managers, safety coordinators, and an internal behavioral safety expert. Department B attendees were managers and the training coordinator whose roles involved safety. In department C, attendees of this meeting were the workers within the department who conducted the pinpointing of task critical behaviors in collaboration with the behavioral safety expert. Each crew within department C (four crews total) had separate meetings to identify pinpoints around tasks they completed and perceived as most critical to safety. Management in department C were involved in the scheduling of crew meetings to meet with the behavioral expert but were not present or consulted with during the pinpointing meeting.

See Appendix C for complete protocol around pinpointing meeting and Appendix D for the tool used to develop pinpoints.

The pinpointing meeting was started by describing the purpose of the meeting. The participants were then asked questions to pinpoint critical tasks that (a) require a lot of experience to learn, (b) have a lot of variation in safe performance, (c) are routinely performed but are associated with significant hazards, (d) are infrequent but complicated, and (e) happen when work gets busy. Critical tasks were prioritized and chosen for observation. Within each critical task, safe behaviors were pinpointed along with discussions of the variance that may occur that make the task riskier. From this process, a final list of critical tasks and behaviors were compiled for each experimental department.

Pinpointed tasks and behaviors were then operationally defined into measurable behaviors. Behaviors were also worded to reflect safe performance and to pass the dead person test (e.g., "moved off platform after starting gear pump" vs. "**did not** move off platform after starting gear pump" or "Put on leather cuff gloves" vs. "**was not** wearing PPE"). These items were then compiled into a checklist specific to each critical task and department. Drafts of these checklists were reviewed by leaders, managers, and safety coordinators in departments A and B and other workers in departments C.

<u>Task-Specific Checklist Implementation (C).</u> After revisions were made to the checklist, finalized versions were then published in the electronic data entry system. Managers and workers were then shown the completed versions in the electronic system and shown how to input the data. After this, data collection began using the specific checklist.

Dependent Variables

Archival data were collected from various databases of the host organization. Behavioral safety process data (i.e., at-risk behavior and participation) were collected and stored in a third-party database platform. Other measures indicative of the effectiveness of the behavioral safety process on other reporting such as near misses, action items, and hazard identifications, as well as outcome data (i.e., injuries and process safety events) were collected by employees, managers, and department leadership and were stored either in the third-party database or in individual database files within the company. These various data sources were gathered by internal members of the company and de-identified before being uploaded to an internet file storage site hosted by the organization. The data were then downloaded to the research institution’s secure files for analyses.

This study analyzed three dependent variables: a) Pinpoints meeting behavioral criteria, b) risk identification, and c) the production of action items from the process.

Behavioral Criteria. To determine how much each department’s intervention checklist conformed to Johnston & Pennypacker’s criterion for behavioral pinpoints (1980), both baseline and intervention checklists were scored on the seven-pinpoint criterion established. The pinpoint should state:

(a) the bodily (or verbal) action that should happen (Johnston & Pennypacker, 1980; Mayer et al., 2019; Miller, 2006; White, 1971),

(b) the physical thing in the environment the behavior is impacting (Johnston & Pennypacker, 1980),

(c) when the behavior should occur (Kazdin, 1994; Mayer et al., 2019), and

(d) what the behavior will achieve (Mayer et al., 2019; Miller, 2006).

The pinpoint must also be:

(e) observable and measurable (Chance, 2006; Johnston & Pennypacker, 1980; Miller, 2006; Sulzer-Azaroff & Austin, 2000; Sulzer-Azaroff & Fellner, 1984),

(f) under the employee's control (Daniels & Bailey, 2014; Sulzer-Azaroff & Fellner, 1984), and

(g) passes the dead-person test (Lindsley, 1991).

Eleven research assistants "blind" to the study were trained on the pinpointing criteria (see Appendix E for training slides). After the initial training, the research assistants completed a practice set of 5 pinpoints and scored the pinpoints based on the seven criteria and were rated for agreement against the primary researcher's ratings using trial-by-trial interobserver agreement (IOA; Cooper et al., 2007).

Average IOA during practice was 75%. After the practice session, the researcher provided feedback to the group and discussed any pinpoints that were scored differently. After feedback, the research assistants completed a second practice set resulting in an average IOA of 80%. Six researchers with IOA above 80% (range: 83-92%) were chosen as raters for the pinpoints generated by the departments.

Baseline and intervention checklist items were randomized across participating department checklists and research assistant scored each checklist item independently on the seven-pinpoint criterion (see Appendix F for the rating form). A score was calculated for each pinpoint based on the mean across the six raters. Pinpoint scores could range from 0-7, with each pinpoint criterion met adding a point to the overall score.

Risk identification. Response options on departmental behavioral checklists included "safe," "at-risk" or "not observed" for each pinpoint. Risk was considered to be identified if the response selected was "at-risk." The data included the date of the observation, the department the observation took place in, and response option selected for each pinpoint (see Appendix G for the electronic checklist interface).

Action items. Action Items are management initiatives to improve safety. These can include repair of equipment, new tool design, improvement in work procedures, additional safety guards, planned training, etc. Action items can be generated from lagging outcomes such as, injuries, worksite audits, and equipment failures. Action items created from behavioral observations (leading indicators) demonstrate management acting upon hazardous conditions and risks prior to adverse safety outcomes (e.g., injuries, equipment failures). Tracking these with risk identified would directly link the observation process with the improvement of safety. These data can be directly linked to behavioral observation data as the database interface allows for an action item to be developed immediately after risk is identified and selected from the observation interface (see Appendix H for the interface). Both the action items from the lagging indicators (e.g., injuries, audits, equipment failures) and action items specifically created from behavioral observations were collected.

Exploratory Variables

Injuries. Injury data were collected from the organization's electronic data storage system. Employees report to their supervisor any level of injury, ranging from incidents not requiring first aid, incidents requiring first aid (OSHA recordable), and injuries that result in lost time and days away from work. The injury is then documented and entered.

Results

Data collection occurred over 21-months (90 consecutive weeks) resulting in a total of 5,802 behavioral observations across the five departments. (Department A: 1311 observations;

Department B: 144 observations; Department C: 860 observations; Department E: 1,961 observations; Department F: 1,526 observations).

During the baseline condition, data were excluded if there was only one observation contributing to the weekly percentage within a department. The exclusionary criteria resulted in nine data points removed from department B's data and one from each of departments A, C, D, and E. After the intervention that changed checklists to task-specific items, observations were limited in frequency to the occasions that the pinpointed tasks were performed in each department. Therefore, the one observation per week criterion was not applied for departmental intervention data. No further adaptations were made to the data.

During pinpointing, Department A identified 8 critical tasks, averaging 3.5 items per task (range: 2-5), for a total of 28 items on the checklist. Department B identified 12 critical tasks, averaging 4.66 items per task (range: 1-10), for a total of 56 items on the checklist. Department C identified 6 critical tasks, averaging 2.5 items per task (range: 1-4), for a total of 15 items on the checklist. Departments D and E were the control departments and had no changes to their general checklist.

Criterion Ratings of Behavioral Pinpointing

See Table 2 for the research assistants' pinpoint ratings on all baseline checklist pinpoints and Table 3 for ratings on all task-specific items. Figure 2 displays the distribution of the average pinpoint ratings for the checklist items for all departments during Baseline and Task-specific Checklist. Pinpoint criterion average scores were calculated with all six research-team raters' scores across all pinpoints for each checklist. Pinpoint scores could range from 0-7. The average behavioral pinpoint criteria met per item in Department A's baseline checklist was 2.36 (*SD* = 1.85). Department B's baseline checklist pinpoint score average was 2.45 (*SD* = 1.74).

Department C's baseline checklist average pinpoint criteria met per item was 0.84 (*SD* = 1.20). The average pinpoint criteria met per item in Department A's task-specific checklist was 1.96 (*SD* = 1.61). Department B's task-specific checklist pinpoint score average was 2.31 (*SD* = 1.62). Department C's task-specific checklist average pinpoint criteria met per item was 4.96 (*SD* = 1.34). See Table 4 for the average and standard deviation of pinpoint scoring per item for each department during both phases. The higher pinpoint scores in the employee driven department supports the hypothesis that employees would develop pinpoints more likely to meet behavioral criteria.

Matching Categories Across General and Task-Specific Checklists

Items on the Baseline general checklist and items on the Intervention task-specific checklists were nonequivalent. There could not be a direct comparison between a general item relating to a response class containing many behaviors (e.g., tools and equipment) and a task-specific item containing a specific behavior (e.g., "put on respirator when trying to unplug tank"). Therefore, pinpoints from the specific checklists were categorized into the prior general behavioral categories established in Baseline. The researcher and another subject matter expert categorized each task-specific pinpoint into a general category. Any discrepancies were discussed between the two raters until an agreement was met for each item categorization. IOA was not calculated for the pinpoint categorizations.

Six baseline categories were established for data analysis:

- Personal protective equipment (PPE). PPE pinpoints are those that involve selection and use of personal protective equipment (e.g., "harness is worn correctly").
- Body use. Body use pinpoints involve direct movement of the employee body (e.g., "correct lifting technique?" and "stood on side of valve opening?").

- Tools and equipment. Tools and equipment involved pinpoints relating to the selection, use, and maintenance of tools and/or equipment (e.g., “lifting device inspected prior to use” and “set up air horn prior to opening sample valve”).
- Policies and procedures. Policies and procedures include pinpoints around employee communication, permits, and procedure adherence (e.g., “Confined Space Permit fill out correctly” and “using personnel lift to perform task? 2 trained lift operators?”).
- Environment and housekeeping. Environment and housekeeping included pinpoints aimed at the housekeeping and maintenance of the operations area (e.g., “floor free of coolant & waste oil” and “cutters stored with covers in place”).
- Positioning of people. Positioning of people involved pinpoints designed to minimize employee overexertion or coming into contact with excessive temperatures (e.g., “extreme temperature precautions taken” and “using techniques to minimize excessive force”).

See Table 5 for experimental department categories and Table 6 for control department categories. Table 7 contains the total number of pinpoints per category and percentage of total pinpoints for each department’s task-specific checklist. 46% of employee pinpoints were categorized in the Body Use categorization. Approximately 27% of management pinpoints were in Environment-and-Housekeeping, and 22% in Policies-and-Procedures. In both employees and management, around 33% of the pinpoints were categorized in Tools-and-Equipment.

Risk Identification

Statistical Process Control (SPC) was used to determine significant changes in variability for the risk identified during baseline and intervention (Mainstone & Levi, 1988; Pfadt & Wheeler, 1995). Upper and Lower Control limits (three standard deviations), Central lines (mean of the time series), and two-sigma limits (two standard deviations) were calculated and variability was analyzed using Pfadt and Wheelers' (1995) four detection rules for detection of special cause of variation (i.e., significant differences): (a) a single point is outside of the upper or lower control limits; (b) two of three data points land outside of two-sigma limits away from the central line; (c) four out of five consecutive data points fall on the same side and more than one sigma unit away (from the central line) indicates special cause of variation; and (d) eight consecutive data points fall on the same side of the central line. Each behavioral category was analyzed for changes in risk identified trends representing special cause variation (i.e., statistical significance).

Risk identification was calculated as the total number of at-risk behavior observed, divided by the sum of the safe and at-risk behavior responses, multiplied by 100 for a percentage.

Personal protective equipment. Figure 3 depicts the PPE categorized pinpoints' weekly risk identification percentage at all five departments across baseline and the intervention of the task-specific checklist. Table 8 reports the means, standard deviations, and upper control limits for each department during both phases.

Department A showed a decrease of 1 percentage point in mean risk identified from baseline to task-specific checklist intervention. The baseline upper control limit was not surpassed with the implementation of the task-specific checklist. A mean increase of 3 percentage points occurred in Department B from baseline to task-specific checklist intervention. Two data points appeared outside baseline upper control limit of 0.0% indicating potential statistical significance and recalculation of control limits. After each data point, an immediate return to baseline level occurred. Therefore, it was determined not to recalculate the upper control limits. Department C experienced a mean decrease of 0.2 percentage points from baseline to task-specific checklist intervention. The baseline upper control limit was not surpassed. PPE did not vary at either of the control departments (i.e., Department D & E). The data from the PPE category refutes the hypothesis that task-specific behavioral pinpoints would identify more risk than general pinpoints.

Body use. Figure 4 depicts the body use categorized pinpoints weekly risk identification percentage at all five departments across baseline and the intervention of the task-specific checklist. Table 9 reports the means, standard deviations, and upper control limits for each department during both phases.

Department A showed a decrease of 0.5 percentage points in mean risk identified from baseline to task-specific checklist intervention. The baseline upper control limit was not surpassed with the implementation of the task-specific checklist. A mean decrease of 0.3 percentage points occurred in Department B from baseline to task-specific checklist intervention. The baseline upper control limit was not surpassed with the implementation of the task-specific checklist. Department C showed an increase of 9.1 percentage points from baseline to task-specific checklist intervention. Four data points appeared outside the baseline upper control limit of 3.7% indicating statistical significance and recalculation of the control limits. A new upper control limit was calculated during the intervention data at 51.9%. Body use did not vary at either of the control departments (i.e., Department D & E). The data from the Body Use category supports the hypothesis that task-specific behavioral pinpoints would identify more risk than general pinpoints. Evidence also supports the hypothesis that employee pinpoints would identify more risk than management pinpoints.

Tools and equipment. Figure 5 displays the tools and equipment categorized pinpoints weekly risk identification percentage at all five departments across baseline and the intervention of the task-specific checklist. Table 10 reports the means, standard deviations, and upper control limits for each department during both phases.

Department A showed a decrease of 1.7 percentage point in mean risk identified from baseline to task-specific checklist intervention. The baseline upper control limit was not surpassed with the implementation of the task-specific checklist. Department B demonstrated an increase of 17.7 percentage points from baseline to task-specific checklist intervention. 10 data points appeared outside the baseline upper control limit of 6.8% indicating statistical significance and recalculation of the control limits. Due to this special cause of variance, a new upper control limit was calculated during the task-specific intervention at 66.2%. Department C showed an increase of 19.8 percent points in mean risk identified from baseline to task-specific checklist intervention. Six data points were outside the baseline upper control limit of 4.6% indicating statistical significance and recalculation of the control limits. Therefore, a new upper control limit was calculated during the intervention data at 82.4%. Department D (control) showed one data point outside the control limit and a new upper control limit was calculated and applied to the full dataset 6.6%. Tools and equipment did not vary at control department E. The data from the tools-and-equipment categorization supports the hypothesis that task-specific behavioral pinpoints would identify more risk than general pinpoints. Evidence does not supports the hypothesis that employee pinpoints would identify more risk than management pinpoints.

Policies and procedures. Figure 6 displays the tools and equipment categorized pinpoints’ weekly risk identification percentage at all five departments across baseline and the intervention of the task-specific checklist. Table 11 reports the means, standard deviations, and upper control limits for each department during both phases.

Department A showed a decrease of 0.4 percentage points in mean risk identified from baseline to task-specific checklist intervention. The baseline upper control limit was not surpassed with the implementation of the task-specific checklist. Department B demonstrated an increase of 6.3 percentage points from baseline to task-specific checklist intervention. Six data points appeared outside the baseline upper control limit of 6.6% indicating statistical significance and recalculation of the control limits. Due to this special cause of variance, a new upper control limit was calculated during the task-specific intervention at 24.1%. Department C showed a decrease of 0.6 percentage points from baseline to task-specific checklist intervention. The baseline upper control limit was not surpassed with the implementation of the task-specific checklist. Policies and procedures did not vary at either of the control departments (i.e., Department D & E). The data from the policies-and-procedures categorization does not support the hypothesis that task-specific behavioral pinpoints would identify more risk than general pinpoints. Evidence does not supports the hypothesis that employee pinpoints would identify more risk than management pinpoints.

Environmental and housekeeping. Figure 7 displays the environment and housekeeping categorized pinpoints weekly risk identification percentage at all five departments across baseline and the intervention of the task-specific checklist. Table 12 reports the means, standard deviations, and upper control limits for each department during both phases.

Department A showed a decrease of 2.5 percentage points in mean risk identification from baseline to intervention. The baseline upper control limit was not surpassed with the implementation of the task-specific checklist. Department B demonstrated a decrease of 1.7 percentage points from baseline to task-specific checklist intervention. The baseline upper control limit was not surpassed with the implementation of the task-specific checklist.

Department C did not have any pinpoints in the environmental and housekeeping categorizing and therefore had no data during the task-specific checklist phase. Department D (control) showed two data point outside the control limit at 5.0%. Department E (control) showed three data points outside the control limit at 12.8%. The data for environment-and-housekeeping categorization does not supports the hypothesis that task-specific behavioral pinpoints would identify more risk than general pinpoints.

Positioning of people. Figure 8 displays the positioning of people categorized pinpoints weekly risk identification percentage at all five departments across baseline and the intervention of the task-specific checklist. Table 13 reports the means, standard deviations, and upper control limits for each department during both phases.

Department A showed a decrease of 0.9 percentage points in mean risk identification from baseline to intervention. The baseline upper control limit was not surpassed with the implementation of the task-specific checklist. Department B demonstrated no change in percentage points from baseline to task-specific checklist. Department C demonstrated no change in percentage points from baseline to task-specific checklist. Positioning of people did not vary at either of the control departments (i.e., Department D & E). The data for the positioning-of-people categorization refutes the hypothesis that task-specific behavioral pinpoints would identify more risk than general pinpoints. Evidence does not supports the hypothesis that employee pinpoints would identify more risk than management pinpoints.

Action Items

Figure 9 depicts the cumulative number of action items created from behavioral observations and the cumulative action items created from other sources (i.e., injuries, audits, and equipment failures), across all departments for both phases. Table 14 reports the overall rates for action items created from behavioral observations and overall rates for action items created from other sources across all departments for both phases. Rates were calculated by taking the total number of action items, divided by the total number of weeks per phase.

For Department A overall response rate for action items from behavioral observations was 0 and action items from other sources was 8.7 over the 68 baseline weeks. During intervention, Department A's rate of action item creation from behavioral observations remained at 0 and action items from other sources was 2.3 over 22 weeks. For Department B the overall response rate for action items from behavioral observations was 0 and action items from other sources was 7 over 72 baseline weeks. During intervention, Department B's response rate for action items from behavioral observations was 0.0 and action items from other sources was 3.9 over 16 consecutive weeks. For Department C the overall rate for action items created from behavioral observations was 0 and action items from other sources was 0.1 over 78 baseline weeks. During intervention, Department C's rate for action items from behavioral observations was 1.8 per week and action items from other sources was 0 per week over 11 consecutive weeks. For Department D (control) the overall response rate for action items from behavioral observations was 0 and action items from other sources was 0.5 over 89 consecutive weeks. For Department E (control) the overall response rate for action items from behavioral observations was 0 and action items from other sources was 0.2 over 91 consecutive weeks.

Injuries

Table 15 reports the injuries for each department during baseline and the task-specific checklist phase. Department A and B had 14 and 31 injuries respectively, Department C had 3 injuries, and Departments D and E had 4 and 7 injuries respectively.

Discussion

The current study evaluated whether task-specific behavioral pinpoints meeting the behavioral criterion would identify more risk than general pinpoints. Management and employee driven pinpoints were also compared. Overall results indicate that task-specific checklists were more successful at aiding workers in identify risk during the observation process than general checklist. Specifically, the employee-designed pinpoints were more likely to conform to the seven-pinpoint behavioral criteria (Johnston & Pennypacker, 1980) and were associated with more risks identified during the subsequent observation process. Employee driven processes also resulted in the creation of more preventative action items during the observation process.

Employee-Driven Pinpoint Process Resulted in More Specific Checklist Items

The present study provided evidence that employee-driven pinpoint processes may result in more specific checklist items that match the behavioral criterion. Employees in Department C created pinpoints that had higher average behavioral criterion scores when compared to the management driven pinpoints created in Department A & B. Employee pinpoint scores also had the lowest standard deviation across research-team raters indicating reliable interpretations of pinpoints as behavioral. Agreement among multiple observers is a necessary feature of a behavioral definition for it to be observable and measurable consistently (Hawkins & Dobes, 1977; Kazdin, 1994; Miller, 2006). Manager created pinpoints had more variability amongst the raters scoring which could be indicative of unclear behavioral pinpoints. The finding that trained raters had more variability in their interpretation of pinpoints may be suggestive of the same phenomena in the workplace where workers may interpret ambiguous pinpoints differently from each other.

The majority of employee pinpoints targeted their immediate task and body movements, indicative of behavioral incidents. Management pinpoints had some behavioral incidents but also were likely to also targeted procedure following and housekeeping (e.g., “Location & tested shower and eye wash”), indicative of the product of behaviors representative of more general response classes). Around half of the management pinpoints were in the Policies-and-Procedures and Environment-and-Housekeeping categories. These difference in pinpoint categories support the notion that management would design pinpoints around “managing” safety with policies and procedures. Because departments A and B performed maintenance work around equipment, their hazards may be more related to the condition of their tools and the equipment. As a result, it is understandable that their pinpoints were focused less on behavior but more around equipment conditions. For example, the checklist item “flange and pipe ends cleaned with rigid lance” did not meet the full pinpoint criterion, yet may be critical to employee safety because this act limits employee exposure to harmful chemicals.

In contrast, nearly half of employee pinpoints were targeting the Body Use category compared to around 10% of the management pinpoints. Body use may be the category that contains the most pinpoints that conform to the behavioral criterion. It certainly was the preferred category of the employees participating in the focus group. As employees engage in their current work conditions, the specific operation of their body either put them at risk in the moment or keeps them from coming into contact with the hazards. Targeting body movement may be reflective of employee participants’ intimate contact with the specific behaviors needed to avoid their workplace hazards.

Employee-Driven Pinpoint Process Resulted in More Risk Identification

Overall, the implementation of the task-specific checklist had the largest impact in risk identification when the pinpoints were developed by the employees. In other words, employee-developed pinpoints resulted in more behaviors rated at-risk during the peer-to-peer behavioral observation process following checklist revisions. However, this result needs to be interpreted with caution as our findings are mixed and need to be replicated.

Employee-driven pinpoints increased risk identification in the Body Use and Tools-and-Equipment categories. The employee driven pinpoints increased risk identification around 10 percentage points in the Body Use categorization and nearly 20 percentage points in the Tools-and-Equipment categorization. Only two of the management pinpoints were associated with increased risk identification when used for observations (i.e., Tools-and-Equipment and Policies-and-Procedures). This finding was limited to the management pinpoints in Department B's observation process around Tools-and-Equipment which was associated with an 18 percentage point increase in risk identification and Policies-and-Procedures, which was a 6 percentage point increase.

In sum, employee-driven processes had both conformed best to our behavioral criterion and were associated with increases in risk identification in the observation process. Both management-driven processes developed pinpoints failed to conform to our behavioral criterion. In fact, their new pinpoint scores were lower than the general categories present during baseline. Except for Department B's pinpoints in Tools-and-Equipment and Policies-and-Procedures, management-driven process demonstrated no change in risk identification across all behavioral categories. This finding coincides with lower pinpointing criterion scores in the management pinpointing process. These results provide evidence that suggest pinpoints that conform to behavioral criteria may result in increased risk identification across some behavioral categories, at least when employees create the pinpoints.

Checklist Length

Differences in the task-specific checklist length were explored post-hoc. The employee driven process adopted the shortest checklist whereas management driven processes resulted in the longest checklists. The employee checklist had 15 items while the two management checklists had 28 and 56 items (departments A and B respectively). It has long been known (Miller, 1956) that humans can retain only around seven, plus or minus two, pieces of information, with more modern estimates ranging from 3-5 depending on the complexity of the stimuli and other variables (Cowan, 2000). If the checklist is long and exceeds employees working memory capacity, rating accuracy may be lower than a shorter, more pinpointed checklist. This could result in the identification of fewer at-risk behaviors when the observer is unable to retain what they observed and then mark less salient items as safe. Although employees created the shortest checklist, risk was not identified across all behavioral categories. The longest checklist developed by managers also identified more risk than the other management checklist that had less items. Although employees adopted shorter checklists than their manager counterparts, these results suggest that checklist length may not be the critical feature impacting the amount of risk identified.

Action Items

Action items are management initiatives to improve safety. Incidents like injuries, audits, and equipment failures often result in the creation of an action item. Unfortunately, the action to improve safety thereby often occurs after the incident related to injury, error or failure had already happened. These action items are reactive and lag the injury. Creating action items from behavioral observations is a proactive method to design changes. Behavior observations obtain information about the current work environment and behaviors that are occurring in the workforce, both safe and at-risk. Identifying variance in these behaviors allows for intervention design to mitigate risk prior to an incident occurring. Behavioral observations also allow for information on current conditions to be collected directly from front-line employees.

No action items were created from behavioral observations during baseline and only the employee-driven process resulted in the creation of action items during the task-specific checklist implementation. Management processes submitted more action items from other sources (e.g., injuries, audits, and equipment failures) compared to the employee process and the control Departments (D & E). The high rate of action items like these may be because management departments experienced the highest number of injuries (Table 15), resulting in action items following investigation. These departments were a maintenance function which may have increased the rate of action items related to equipment failures.

After the implementation of the task-specific checklist, the employee-driven process was the only department to begin an increase in action items created from behavioral observations. An overall rate of 1.8 action items per week were developed from the employee-driven process. The employee-driven pinpoints were associated with increases in risk identification, which were associated with the increase in preventative action items generated from behavioral observations. This supports McSween and Morans' (2017) assertion that the identification of high-risk tasks and clearly defined behavior pinpoints would result in better initiatives to mitigate future risk.

Increasing action items created from behavioral observations is critical as observations are leading indicators that can be acted upon to mitigate the potential of SIFs, whereas action items from other sources are lagging and are created after the injury, equipment failure, or SIF has already occurred.

Injuries

Specific checklists and pinpoints are designed to capture variance in high-risk tasks. Identifying variance in these tasks may provide more information for eventual systematic intervention to minimize risk and prevent injury. A general checklist may not identify variance in behavior as the pinpoints are too ambiguous. A specific checklist should have pinpoints that are unambiguous and result in greater identification of risk.

In the current study, task-specific pinpoints, with greater criterion scores, did result in increased risk identification. Risk identification also was associated with an increase in the creation of preventative action items to minimize hazards. However, no inferences can be made as to whether the task-specific checklists resulted in a decrease of injuries for any departments as the duration of the task-specific checklist intervention was limited. Correlations could be conducted to examine the relationship between task-specific checklist risk identified and injuries. However, as injuries are a low base rate event it may not be statistically feasible to predict such outcomes.

Limitations

A limitation to the study is the length of the intervention. The longest intervention phase data were collected for 23 weeks (Department A) and the shortest at 11 weeks (Department C). The 2020 COVID-19 pandemic further truncated behavioral observation collection due to plant slowdowns and social distancing. Preliminary results indicate that risk identification increased when employees identified and adopted task-specific pinpoints. However, long-term data collection is required to determine if the increases in risk identification can be maintained.

A potential confounding variable was the reduction of the quota in the employee pinpointing process. The employee pinpointing process decreased the required quota from six to one, at the onset of the intervention. The change in quota may have been correlated with the increases in risk identification found in Department C's Body Use and Tools-and-Equipment categories. However, as none of the other categories increased risk identification that does not appear to be the case. One of the management driven processes (Department B) also demonstrated an increase in risk identification during the task-specific checklist implementation and had no change to the quota from baseline. The results suggest that the change in quota may not have influenced the task-specific checklist intervention.

Another limitation is how frequently specific tasks may be available for observation, creating gaps in the data. If a task did not occur in a given week, an observation could not be recorded. This can be seen in Department C's Policies and Procedures categorization, in which six consecutive weeks passed between observations of the targeted infrequent task.

The risk identification calculation is also impacted by the frequency of task occurrence. If a given task only occurred once that week then only one observation could occur. The data from the one observation would then be used to calculate the weekly risk identification percentage. The calculation would result in drastic percentages. For example, in week 81 department C had 0% risk identification for the Tools-and-Equipment categorization. The percentage was calculated off one observation of an infrequent task which resulted in two pinpoints being scored as safe for that observation.

A limitation to the study were the mixed results found in risk identification across the behavioral categories. As risk identification was the primary dependent variable of the study demonstrating control in its changes was important. Despite the increased pinpointing scores for the employee pinpointing process, risk was not identified consistently across the behavioral categories. Increased variability only occurred in Body Use and Tools-and-Equipment categories with no change in PPE, Policies-and-Procedures, and Positioning of People. A potential explanation for these results may be that pinpoints in PPE, Policies and Positioning were already occurring safely nearly all the time. For example, the PPE category had one pinpoint, "put on (PPE) prior to touching bolts with hand" and Position of People asked, "if bolt is too hot, took break to avoid heat." Both items were related to the same task and it is likely that putting on gloves minimized the risk of heat exposure while working and therefore would coincide with a safe response in the second pinpoint. As PPE is commonly a frequently safe response (CCBS, 2017) it is understandable if no risk occurred in these items. As their process matures, the employees may elect to drop these pinpoints from their checklist if near 100% safe observations continue.

Another limitation to the study was the lack of random assignment to intervention groups. By not randomly assigning experimental groups, the intervention may have been influenced by differences in the departments. Participation in the task-specific checklist intervention was selected by the division leadership. Determining whether pinpointing would be done by management or employees was also subjective to department leadership preferences.

A limitation to the study was in how the checklist items were sorted into the categories. Because range restriction was present in the baseline checklist items it was not possible to correlate each task-specific pinpoint to a respective baseline pinpoint. Therefore, the researchers grouped the task-specific pinpoints into each baseline behavioral category without statistical evidence that the items were equivalent.

A final limitation are the history effects that may have impacted risk identification outside of the task-specific checklist intervention. First, several departments experienced operational shutdowns over the course of the study. During these shutdowns the employee workforce is decreased and the equipment is no longer in production. These shutdowns severely limit the opportunities for observations to occur, especially during the task-specific intervention phase, as the task is no longer occurring. Second, other safety initiatives may have been occurring simultaneous to the task-specific checklist intervention. For example, over the course of the study changes to a work permit were ongoing and may have facilitated additional awareness around safety, which may have impacted the risk identification found. Third, the 2020 COVID-19 outbreak limited the data collection as operation employees were required to limit interactions in the field, severely impacting the potential for behavioral observations.

Practical Implications

The seven-pinpoint criteria, established in the behavior analytic literature and summarized here, can be used as a guide to develop and evaluate pinpoints for selection into behavioral safety checklists. Training facilitators of the pinpointing sessions on the seven-pinpoint criteria may assist in the development of a task-specific pinpoint that may be more successful in identifying risk.

Involving employees in the pinpointing process may help practitioners develop better pinpoints around the behaviors proximal to the tasks employees engage in. This may be especially true of specific body movements that employees need to engage to avoid exposure to hazards. These pinpoints may prove to be most crucial in reducing workplace injuries. On the other hand, managers may be better candidates for assisting in pinpointing around policy-and-procedures. The later recommendation should be proceeded with caution as the findings were mixed for manager success in pinpointing behaviors that resulted in risk identification.

Lastly, task-specific checklists may be better suited for behavior categorizations around the immediate body movements and tools-and-equipment as opposed to PPE, policies-and-procedures, and environment-and-housekeeping behaviors. Pinpoints around body movement and tools-and-equipment were shown to identify the most risk and led to the creation of more preventative action items. An organization seeking to identify risk and design interventions to mitigate that risk may be best suited to pinpoint behaviors within the body use and tools-and-equipment categories. However, as each organization’s hazards are unique, practitioners should explore which behavioral categories warrant task-specific pinpoints on a case-by-case basis. The practitioner is then recommended to apply the seven-pinpoint criteria to behaviors within those tasks.

Future Research

In future research, studies should explore which of the seven-pinpoint criteria established in this study are necessary for the identification of risk in a behavioral safety process. Researchers could develope checklist items with different combinations of the pinpoint criteria then observe which items indentify more risk through behavioral observations. Including a correlational analysis between each pinpoint criteria and risk identified would provide further evidence for which criteria are necessary.

A true comparision between general response class pinpoints and task-specific pinpoints could not be made in this study across all departments. The baseline checklists in Departments A and B met some of the pinpoint criteria and were not all general response class pinpoints. The baseline checklist items in Department C were general response class pinpoints. Results in Department C provided evidence that task-specific pinpoints resulted in more variance than the general response class checklist. Replicating the findings in Department C would provide further evidence that task-specific pinpoints are better than general response classes in an observation process. The resulting study would answer previous calls for research on the subject (Wirth & Sigurdsson, 2008).

Further research could explore what personnel are neccesary in the development of the specific pinpoints that identify risk. The results of this study found that employee pinpoints identified more risk in pinpoints categorized around Body Use,whereas one of the management driven departments demonstrated slight increases in risk identification in the Policies-and-Procedures category. The employee driven pinpoints did not identify any risk in the Policies-and-Procedures category and management pinpoints did not identify risk in the Body Use cateogry. Perhaps indicating that for the greatest risk identification to occur, employees should develop pinpoints that involve there immediate job and body movements, and managers should develop pinpoints around procedures and communication. Future research should explore these differences in poinpoint categories.

Researchers could also explore which of the categories should be pinpointed for risk identification. In the current study, although pinpoints were created around PPE and Environment-and-Housekeeping, minimal risk was identified with these pinpoints. A task-specific checklist should identify high-hazard and high-variance tasks that could result in injury. By exploring the relationship between PPE and Environment-and-Housekeeping to injuries, researchers could determine whether these behavioral categories warrant pinpointing for a task-specifc checklist.

Summary

The current study demonstrated preliminary evidence that task-specific checklists identify more risk in a behavioral observation process and result in the creation of more preventative action items than general checklist items. Employees also appear to be better subject matter experts in developing behavioral pinpoints for task specfic checklist compared to management. Finally, this study provides a base direction for research to further investigate how behavioral safety can be improved to identify critical tasks to minize potential for SIFs and limit human suffering in the workplace.

References

Bumstead, A., & Boyce, T. E. (2005). Exploring the effects of cultural variables in the implementation of behavior-based safety in two organizations. *Journal of Organizational Behavior Management*, *24*, 43–63. doi: 10.1300/J075v24n04_03

Bureau of Labor Statistics [BLS]. (2018a). *Employer-reported workplace injuries and illnesses 2017, USDL-18-1788.*

Bureau of Labor Statistics [BLS]. (2018b). *National census of fatal occupational injuries in 2017, USDL-18-1978.*

Cambridge Center for Behavioral Studies. (2017, June 29). *Companies achieving behavioral safety accreditation*. Retrieved from https://behavior.org/help-centers/safety/Accredited%20Companies/

Cambridge Center for Behavioral Studies. (2020, March 15). *Companies achieving behavioral safety accreditation*. Retrieved from https://behavior.org/help-centers/safety/Accredited%20Companies/

Chance, P. (2006). *Learning & Behavior* (5th ed.). Belmont, CA: Thomson Wadsworth.

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied Behavior Analysis* (2nd ed.). Upper Sadle River, New Jersey: Pearson Education, Inc.

Cooper, M. D. (2006). Exploratory analyses of the effects of managerial support and feedback consequences on behavioral safety maintenance. *Journal of Organizational Behavior*, *26*(3), 1–41. doi: 10.1300/J075v26n03_01

Cooper, M. D. (2009). Behavioral safety interventions: A review of process design factors. *Professional Safety*, *54*, 36.

Copeland, J. E., Ludwig, T. D., Bergman, S., & Acikgoz, Y. (2018). Increasing sales by managing the interlocking contingencies between sales representatives and customers using behavioral self-monitoring. *Journal of Organizational Behavior Management*, *38*, 116–143. doi: 10.1080/01608061.2017.1423147

Cowan, N. (2000). The magical number 4 in short-term memory: A reconsideration of mental storage capacity. *Behavioral and Brain Sciences*, *24*, 87–185. doi: 10.1017/S0140525X01003922

Daniels, A. C., & Bailey, J. S. (2014). *Performance Management Changing Behavior That Drives Organizational Effectiveness* (5th ed.). Atlanta: Aubrey Daniels International, Inc.

Depasquale, J. P., & Geller, E. S. (1999). Critical success factors for behavior-based safety: A study of twenty industry-wide applications. *Journal of Safety Research*, *30*, 237–249. doi: 10.1016/S0022-4375(99)00019-5

Fellner, D. J., & Sulzer-Azaroff, B. (1984). Increasing industrial safety practices and conditions through posted feedback. *Journal of Safety Research*, *15*, 7–21. doi: 10.1016/0022-4375(84)90026-4

Grindle, A. C., Dickinson, A. M., & Boettcher, W. (2000). Behavioral safety research in manufacturing settings: A review of the literature. *Journal of Organizational Behavior Management*, *20*, 29–68. doi: 10.1300/J075v20n01_03

Guo, B. H. W., Goh, Y. M., & Le Xin Wong, K. (2018). A system dynamics view of a behavior-based safety program in the construction industry. *Safety Science*, *104*, 202–215. doi: 10.1016/j.ssci.2018.01.014

Hawkins, R. P., & Dobes, R. R. (1977). Behavioral definitions in applied behavior analysis: Explicit or implicit? In J. M. Etzel, D. M. LeBlanc, & D. M. Baer (Eds.), *New developments in behavioral research: Theory, method, and application* (pp. 167–188). Hillsdale, NJ:

Erlbaum.

Johnston, J. M., & Pennypacker, H. S. (1980). *Strategies and Tactics of Human Behavioral Research*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Kazdin, A. E. (1994). *Behavior Modification in Applied Settings* (4th ed.). Pacific Grove, CA: Brookes/Cole Publishing Company.

Killimett, P. T. (1991). The identification of critical behaviors: The first step in a behavior-based safety process. *TAPPI*, *74*, 251–253.

Komaki, J. L., Barwick, K. D., & Scott, L. R. (1978). A behavioral approach to occupational safety: Pinpointing and reinforcing safe performance in a food manufacturing plant. *Journal of Applied Psychology*, *63*, 434–445. doi: 10.1037/0021-9010.63.4.434

Krause, T. R., Seymour, K. J., & Sloat, K. C. M. (1999). Long-term evaluation of a behavior-based method for improving safety performance: a meta-analysis of 73 interrupted time-series replications. *Safety Science*, *32*, 1–18. doi: 10.1016/S0925-7535(99)00007-7

Lebbon, A., Sigurdsson, S. O., & Austin, J. (2012). Behavioral safety in the food services industry: Challenges and outcomes. *Journal of Organizational Behavior Management*, *32*, 44–57. doi: 10.1080/01608061.2011.592792

Lindsley, O. R. (1991). From technical jargon To plain English for application. *Journal of Applied Behavior Analysis*, *24*, 449–458. doi: 10.1901/jaba.1991.24-449

Ludwig, T. D., & Geller, E. S. (1997). Assigned versus participative goal setting and response generalization: Managing injury control among professional pizza deliverers. *Journal of Applied Psychology*, *82*, 253–261. doi: 10.1037/0021-9010.82.2.253

Mainstone, L. E., & Levi, A. S. (1988). Fundamentals of statistical process control. *Journal of Organizational Behavior Management*, *9*, 5–22. doi: 10.1300/J075v09n01_02

Matey, N., Gravina, N., Rajagopal, S., & Betz, A. (2019). Effects of feedback delivery requirements on accuracy of observations. *Journal of Organizational Behavior Management*, *39*, 247–256. doi: 10.1080/01608061.2019.1666773

Mayer, G. R., Sulzer-Azaroff, B., & Wallace, M. (2019). Behavior analysis for lasting change. In *Behavior analysis for lasting change.* (4th ed.). Retrieved from http://ezproxy.usherbrooke.ca/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=1992-97850-000&site=ehost-live

McSween, T. E. (2003). *Value-Based Safety Process Improving Your Safety Culture With Behavior-Based Safety* (2nd ed.). Retrieved from www.copyright.com.

McSween, T., & Moran, D. J. (2017). Assessing and preventing serious incidents with behavioral science: Enhancing heinrich's triangle for the 21st century. *Journal of Organizational Behavior Management*, *37*, 283–300. doi: 10.1080/01608061.2017.1340923

Miller, G. A. (1956). The magical number seven, plos or minus two: Some limits on your capacity for processing information. *The Psychological Review*, *63*, 81–97.

Miller, L. K. (2006). *Principles of Everyday Behavior Analysis* (4th ed.). Belmont, CA: Thomson Wadsworth.

Myers, W. V., McSween, T. E., Medina, R. E., Rost, K., & Alvero, A. M. (2010). The implementation and maintenance of a behavioral safety process in a petroleum refinery. *Journal of Organizational Behavior Management*, *30*, 285–307. doi: 10.1080/01608061.2010.499027

Pfadt, A., & Wheeler, D. J. (1995). Using statistical process control to make data-based clinical decisions. *Journal of Applied Behavior Analysis*, *28*, 349–370. doi: 10.1901/jaba.1995.28-349

Pransky, G., Snyder, T., Dembe, A., & Himmelstein, J. (1999). Under-reporting of work-related disorders in the workplace: A case study and review of the literature. *Ergonomics*, *42*, 171–182. doi: 10.1080/001401399185874

Reber, R. A., & Wallin, J. A. (1984). The effects of training, goal setting, and knowledge of results on safe behavior: A component analysis. *The Academy of Management Journal*, *27*, 544–560.

Sulzer-Azaroff, B., & Austin, J. A. (2000). Does BBS work. *Professional Safety*, 19–24.

Sulzer-Azaroff, B., & De Santamaria, M. C. (1980). Industrial safety hazard reduction through performance feedback. *Journal of Applied Behavior Analysis*, *13*, 287–295. doi: 10.1901/jaba.1980.13-287

Sulzer-Azaroff, B., & Fellner, D. J. (1984). Searching for performance targets in the behavioral analysis of occupational health and safety: An assessment strategy. *Journal of Organizational Behavior Management*, *6*, 53–65. doi: 10.1300/J075v06n02_09

Sulzer-Azaroff, B., Loafman, B., Merante, R. J., & Hlavacek, A. C. (1990). Journal of organizational behavior improving occupational safety in a large industrial plant. *Journal of Organizational Behavior Management*, *11*, 99–120. doi: 10.1300/J075v11n01_07

White, O. R. (1971). *A glossary of behavioral terminology*. doi: 10.1017/CBO9781107415324.004

Wilder, D. A., Lipschultz, J. L., King, A., Driscoll, S., & Sigurdsson, S. (2018). An analysis of the commonality and type of preintervention assessment procedures in the journal of organizational behavior management (2000-2015). *Journal of Organizational Behavior Management*, *38*, 1–13. doi: 10.1080/01608061.2017.1325822

Wirth, O., & Sigurdsson, S. O. (2008). When workplace safety depends on behavior change:

Topics for behavioral safety research. *Journal of Safety Research*, *39*, 589–598. doi: 10.1016/j.jsr.2008.10.005

Tables

Table 1

The Number of Weeks each Department Spent in each Experimental Phase

	Total Baseline	Pinpointing	New Checklist Implemented
Department A	67	1 (Managers)	23
Department B	72	2 (Managers)	17
Department C	78	2 (Employees)	11
Department D	88		
Department E	88		

Table 2

Baseline Checklist Pinpoint Ratings Across Raters

Department	Pinpoint	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5	Rater 6	*M*	(SD)
A (Management)	Correct PPE noted by Operations on SWP?	0	4	2	1	2	4	2.17	(1.60)
	Correct PPE worn by Craftspeople?	1	4	2	3	4	3	2.83	(1.17)
	Is material free of burrs?	1	3	2	0	2	2	1.67	(1.03)
	Is local exhaust being used during welding?	6	4	3	2	4	5	4.00	(1.41)
	Is LEV as close as possible to the welding?	1	3	2	1	6	0	2.17	(2.14)
	Is correct respiratory equipment used according to the chemical hazards present?	3	4	2	1	4	4	3.00	(1.26)
	Is the body positioned to avoid sparks & U.V. light?	3	5	3	3	5	4	3.83	(0.98)
	Is the work grounded?	1	2	2	0	1	0	1.00	(0.89)
	What could destabilize object? What direction will gravity take object?	0	0	0	0	1	0	0.17	(0.41)
	Where is the stored energy?	0	0	0	0	1	1	0.33	(0.52)
	Where are the pinch points with this machine/equip.?	0	0	0	0	3	1	0.67	(1.21)
	Tool used (instead of body) to stabilize / hold object?	6	5	2	1	5	4	3.83	(1.94)
	Object is secured / Sling holding object is secured?	2	5	2	0	4	1	2.33	(1.86)
	Object is attached to correct positioner?	2	2	2	2	2	2	2.00	(0.00)
	How can plate clamps lead to injury or damage?	0	1	0	0	2	1	0.67	(0.82)
	What are the critical lift requirements?	0	0	0	0	1	0	0.17	(0.41)
	What parts of equip. did you inspect before lifting?	0	3	1	2	3	3	2.00	(1.26)
	What was pedestrian control plan for clear path?	0	0	0	0	3	0	0.50	(1.22)
	During lifting, what damage could occur to chockers, body parts, equipment?	0	1	1	1	4	4	1.83	(1.72)
	Slow pivoting / turning?	4	4	2	0	3	0	2.17	(1.83)
	Used 3-points of contact?	5	4	2	2	4	3	3.33	(1.21)
	Tested footing before committing weight when stepping?	6	5	5	6	5	4	5.17	(0.75)
	Fall protection is being used?	5	4	2	1	4	4	3.33	(1.51)
	Harness is worn correctly?	1	4	2	1	3	3	2.33	(1.21)

Department	Pinpoint	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5	Rater 6	*M*	(SD)
	Scaffolding built correctly so craftspeople can reach equip.?	2	4	3	3	5	4	3.50	(1.05)
	Fixtures / equipment used to hold things?	2	2	1	0	3	2	1.67	(1.03)
	When retrieving items/pulling equip., load <1ft from chest?	6	6	6	6	6	5	5.83	(0.41)
	When lifting, load is close/against body	6	5	3	5	5	5	4.83	(0.98)
	Floor has good traction (no grease, water, ice, oils, etc.)?	0	3	2	0	2	1	1.33	(1.21)
	Station is clear of hoses, power cords, scrap materials?	3	2	2	1	3	2	2.17	(0.75)
B (Manager)	Truck, pump, and hoses inspected daily?	6	5	2	2	6	5	4.33	(1.86)
	JSR: Jointly identified equipment in field with Operations?	0	3	0	1	3	4	1.83	(1.72)
	Know location Zone, EAP, TH, closest escape route?	0	3	0	1	4	2	1.67	(1.63)
	Know location of closest safety shower/eyewash station?	1	3	0	0	4	3	1.83	(1.72)
	Is there an approved tie off point?	1	2	1	0	2	0	1.00	(0.89)
	Safe Work/Hot Work filled out completely by Operations?	4	4	1	1	4	4	3.00	(1.55)
	Correct PPE noted by Operations?	0	4	2	2	2	4	2.33	(1.51)
	Correct PPE worn by Mechanics?	4	4	2	4	4	2	3.33	(1.03)
	Rig setup: scan hazards?	3	5	2	1	4	4	3.17	(1.47)
	Rig leveling: Setting up on incline?	4	3	2	0	5	4	3.00	(1.79)
	Orange cones set around truck	2	4	2	2	5	2	2.83	(1.33)
	Wheel chocks used correctly?	6	4	2	0	4	4	3.33	(2.07)
	Work area identified with Blue Hydro tape? Signs?	1	4	2	2	2	2	2.17	(0.98)
	Are required drains covered	1	1	1	2	2	2	1.50	(0.55)
	Where are possible overhead drips?	1	1	0	0	3	0	0.83	(1.17)
	Railroad tracks: Rig is 10 ft off center of tracks?	1	3	1	2	2	2	1.83	(0.75)
	Railroad tracks: If rig within 10 ft, tracks locked out?	6	5	3	3	3	2	3.67	(1.51)
	How did today's weather impact equipment operations?	0	0	0	0	1	3	0.67	(1.21)

Department	Pinpoint	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5	Rater 6	*M*	(SD)
	What could go wrong? What would you do then?	0	0	0	0	0	0	0.00	(0.00)
	Confined space walked down with Ops./Plant Protection?	4	4	1	2	6	3	3.33	(1.75)
	Can confined space be entered and exited safely?	1	3	2	0	3	0	1.50	(1.38)
	Temperature of vessel? What's temp. to work safely?	1	1	0	1	3	0	1.00	(1.10)
	Is body position out of line of fire (dropped objects)?	0	3	2	1	3	1	1.67	(1.21)
	Slow pivoting / turning?	4	4	2	0	3	0	2.17	(1.83)
	Used 3-points of contact?	6	2	2	3	4	3	3.33	(1.51)
	Tested footing before committing weight when stepping?	5	5	3	5	5	4	4.50	(0.84)
	Floor has good traction (no grease, water, ice, oils, etc.)?	1	0	2	1	2	2	1.33	(0.82)
	Tripping Hazards (hoses walkways, pipe, wood, skids)	1	2	2	0	2	0	1.17	(0.98)
	Correct tool for the task?	0	2	2	0	3	0	1.17	(1.33)
	Correct HB PPE? Has PPE been inspected for wear?	4	4	2	3	5	4	3.67	(1.03)
	Can the dump gun operator see the lance operator?	0	4	2	2	4	2	2.33	(1.51)
	Lighting adequate for the task?	1	1	1	0	1	0	0.67	(0.52)
	Lance operator/crew members out of the line of fire?	2	3	2	0	3	2	2.00	(1.10)
	Shielding to protect pedestrians?	1	3	0	2	5	3	2.33	(1.75)
	Hoses & equipt. good working condition? Inspected?	5	4	2	0	6	4	3.50	(2.17)
	Whip checks installed correctly?	1	4	2	0	5	2	2.33	(1.86)
	Fall protection is required & used?	4	4	2	2	4	4	3.33	(1.03)
	Harness is worn correctly?	3	5	2	4	3	3	3.33	(1.03)
	Scaffolding built correctly so mechanics can reach equip.?	4	2	2	1	5	3	2.83	(1.47)
	Fixtures / equipment used to hold things?	5	4	2	0	3	3	2.83	(1.72)
	Are they using correct force needed for that tool / equip.?	5	4	2	1	2	2	2.67	(1.51)
	When retrieving items/pulling equip., load <1ft from chest?	6	6	3	6	6	5	5.33	(1.21)
	When lifting, load is close/against body	6	5	3	5	5	5	4.83	(0.98)
C (Employee)	1.1 Hand Protection	1	1	2	1	2	0	1.17	(0.75)

Department	Pinpoint	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5	Rater 6	*M*	(SD)
	1.2 Eye/Face Protection	0	2	2	1	2	0	1.17	(0.98)
	1.3 Protective Clothing	0	1	0	0	2	0	0.50	(0.84)
	1.4 Head Protection	0	1	2	1	2	0	1.00	(0.89)
	1.5 Respiratory Protection	2	0	2	0	0	0	0.67	(1.03)
	1.6 Hearing Protection	0	2	2	1	2	0	1.17	(0.98)
	2.1 Eyes on Hands	2	2	2	3	3	4	2.67	(0.82)
	2.2 Line of Fire / Pinch Points	0	1	2	0	1	0	0.67	(0.82)
	2.3 Eyes on Path	0	5	2	3	4	1	2.50	(1.87)
	2.4 Body Position (Ergonomics)	0	2	0	1	2	0	0.83	(0.98)
	2.5 Hurrying/Rusing	4	3	2	0	1	0	1.67	(1.63)
	2.6 Lifting	4	4	0	0	3	0	1.83	(2.04)
	3.1 Tools and Equipment Condition	0	0	0	0	2	1	0.50	(0.84)
	3.2 Tool and Equipment Selection and Use	0	0	0	0	1	0	0.17	(0.41)
	3.3 Ventilation	0	0	2	0	0	0	0.33	(0.82)
	3.4 Glassware	0	0	1	0	1	0	0.33	(0.52)
	4.1 Communication	0	2	1	0	4	0	1.17	(1.60)
	4.2 Lock Out / Tag Out	0	0	0	0	0	1	0.17	(0.41)
	4.3 Permits	0	0	0	0	1	0	0.17	(0.41)
	4.4 JSA / Test Method / Operating Procedures	0	0	0	0	0	0	0.00	(0.00)
	4.5 Hazard Recognition and Control	0	2	0	0	1	0	0.50	(0.84)
	4.6 Knows location of nearest eyewash and shower	1	3	0	1	4	3	2.00	(1.55)
	5.1 Chemical Storage/Disposal/Handling	0	0	0	0	1	1	0.33	(0.52)
	5.2 Housekeeping	0	0	0	0	3	1	0.67	(1.21)
	5.3 Physical Condition	0	0	0	0	0	0	0.00	(0.00)
	6.1 Mobile Equipment	0	0	0	0	2	0	0.33	(0.82)
	6.2 Chemical Labeling	0	3	1	0	1	0	0.83	(1.17)
	6.3 Other	0	0	0	0	0	0	0.00	(0.00)
	7.1 Striking Against Objects	5	4	1	0	2	0	2.00	(2.10)
	7.2 Struck by Objects	1	1	1	0	1	0	0.67	(0.52)
	7.3 Caught In/On/Between Objects	2	1	2	0	0	2	1.17	(0.98)
	7.4 Contacting Temperature Extremes	0	0	0	0	0	0	0.00	(0.00)
	7.5 Contacting Electrical Current	1	0	1	0	3	0	0.83	(1.17)
	7.6 Overexertion	0	0	1	0	0	0	0.17	(0.41)
	7.7 Repetitive Motions	4	0	2	0	2	0	1.33	(1.63)

Note. Table displaying the raters scoring of pinpoint criteria per pinpoint. Pinpoints were rated from 0-7 based on the seven pinpointing criterion. Pinpoints receive one point for each of the criteria met.

Table 3

Task-specific Checklist Pinpoint Ratings Across Raters

Department	Pinpoint	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5	Rater 6	*M*	(SD)
A (Management)	Jaws / fixtures set properly, including the safety stops?	2	4	2	1	5	4	3.00	(1.55)
	Clamps, t-nuts, etc. in good shape?	1	3	1	0	3	1	1.50	(1.22)
	Can employee perform this function safely without assistance?	0	0	1	1	0	0	0.33	(0.52)
	Correct tool used for task?	5	3	2	1	3	4	3.00	(1.41)
	Machine guards in place?	1	3	2	1	3	2	2.00	(0.89)
	Machine functioning properly?	2	1	1	0	2	0	1.00	(0.89)
	Using techniques to minimize excessive force / gripping to manipulate tools and equipment?	7	4	5	1	5	4	4.33	(1.97)
	Has anything been improvised or fixed to make due, to get job done?	0	3	3	0	3	2	1.83	(1.47)
	Wearing proper PPE when needed?	3	3	2	4	4	4	3.33	(0.82)
	Chemical concerns?	0	0	0	0	0	0	0.00	(0.00)
	Lifting devices inspected prior to use?	6	5	2	3	6	5	4.50	(1.64)
	Proper lifting devices used? Quick sleeves used?	4	4	2	2	4	4	3.33	(1.03)
	Bystanders aware and at a safe distance?	1	1	2	0	3	1	1.33	(1.03)
	Lifting equipment stored properly?	5	4	2	2	4	3	3.33	(1.21)
	Burrs or sharp edges present?	1	1	1	1	3	1	1.33	(0.82)
	Aware of pinch points and hand traps?	0	3	0	0	4	4	1.83	(2.04)
	Body positioned correctly?	2	3	2	1	3	0	1.83	(1.17)
	Correct lifting technique?	4	3	2	1	3	2	2.50	(1.05)
	Repetitive motion?	4	3	1	0	2	0	1.67	(1.63)
	Any trip / slip hazards?	0	2	2	0	2	1	1.17	(0.98)
	Work table cluttered?	0	3	2	1	4	1	1.83	(1.47)
	Equipment / floor free of shavings?	0	2	2	0	2	2	1.33	(1.03)
	Cutters stored with covers in place?	0	3	2	0	5	4	2.33	(2.07)
	Decontamination tag present & correct?	1	3	2	1	2	2	1.83	(0.75)

Department	Pinpoint	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5	Rater 6	*M*	(SD)
	Coolant contaminated?	1	3	1	0	1	0	1.00	(1.10)
	Floor free of coolant & waste oil?	1	3	2	0	2	0	1.33	(1.21)
	>1 can of aerosol product at work station?	2	3	2	1	4	0	2.00	(1.41)
	Chemical concerns?	0	0	0	0	0	0	0.00	(0.00)
B (Manager)	Truck, pump, and hoses inspected daily?	6	5	2	2	6	5	4.33	(1.86)
	Extreme temperature precautions taken	2	3	1	0	3	2	1.83	(1.17)
	4-man crew	1	0	1	0	1	0	0.50	(0.55)
	Jointly identified equip in field	5	4	2	1	2	4	3.00	(1.55)
	Zone, Temporary Haven, EAP identified	1	1	0	0	4	3	1.50	(1.64)
	Planned escape route	1	2	1	0	2	0	1.00	(0.89)
	Location & tested shower and eye wash	0	3	0	1	5	4	2.17	(2.14)
	Area clear of tripping hazards, hoses, scrap, equip.	1	2	2	1	2	2	1.67	(0.52)
	Safe Work Permits filled out correctly	1	4	1	1	5	2	2.33	(1.75)
	Hot Work Permit filled out correctly	2	5	2	3	3	2	2.83	(1.17)
	Confined Space Permit fill out correctly	4	4	1	1	5	2	2.83	(1.72)
	Current temperature of equipment	1	1	1	1	2	0	1.00	(0.63)
	Blue HP tape around work area	2	3	2	1	2	2	2.00	(0.63)
	Crescent wrench appropriate tool	0	3	2	0	1	0	1.00	(1.26)
	Channel-locks appropriate tool	0	2	1	0	2	0	0.83	(0.98)
	Orange cone marking safe work boundary around the rig	1	4	2	1	3	2	2.17	(1.17)
	Is the Rig level	1	4	2	1	2	2	2.00	(1.10)
	Blast hose routed away from walkway if possible	2	4	2	2	3	2	2.50	(0.84)
	Equipment flushed to check for debris and blown out orifices	6	5	2	3	6	5	4.50	(1.64)
	Whip checks used properly	4	4	2	0	4	3	2.83	(1.60)
	PPE (HB policy followed)	0	4	2	1	2	3	2.00	(1.41)
	Equipment is inspected	5	4	1	1	4	4	3.17	(1.72)
	Safety Equipment worn correctly	5	4	2	1	3	3	3.00	(1.41)

Department	Pinpoint	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5	Rater 6	*M*	(SD)
	What energy is present? (Steam, line plugged, head pressure)	0	2	1	0	2	1	1.00	(0.89)
	Can worker be "out of the line of fire"	1	1	2	0	2	0	1.00	(0.89)
	Aware of the possibility of stored/trapped energy	0	2	0	0	4	0	1.00	(1.67)
	Can "Hands Free" equipment be used	0	4	2	0	0	0	1.00	(1.67)
	"Hands Free" equipment set up correctly	1	4	2	0	4	2	2.17	(1.60)
	What could go wrong? What would you do then?	0	0	0	0	0	0	0.00	(0.00)
	Pump Operator on the Rig	2	2	1	1	5	2	2.17	(1.47)
	Pump Operator wearing his headset	3	4	2	3	4	3	3.17	(0.75)
	Dump Gun Operator Position - Line of sight with lance operator	2	3	2	3	3	2	2.50	(0.55)
	Lance/hose/fitting/nozzle inspection	5	3	0	0	5	0	2.17	(2.48)
	Changed operations based on weather conditions	0	4	2	1	2	3	2.00	(1.41)
	Fall protection is being used	5	3	2	1	4	4	3.17	(1.47)
	Harness is inspected before use? What did you inspect?	6	5	2	3	5	4	4.17	(1.47)
	Harness is worn correctly	3	4	2	2	3	2	2.67	(0.82)
	Used 3 -points of contact	4	2	2	3	4	3	3.00	(0.89)
	Scaffolding built correctly to reach equip	1	2	2	3	5	4	2.83	(1.47)
	Using personnel lift to perform task? (JLG) 2 trained lift operators?	4	3	2	1	4	3	2.83	(1.17)
	Flange and pipe ends cleaned with rigid lance	5	5	2	2	6	4	4.00	(1.67)
	Can backout device make job safer	0	0	0	0	1	2	0.50	(0.84)
	Stored energy concerns addressed	0	2	1	1	2	2	1.33	(0.82)
	Proper stinger length per diameter of pipe	0	3	1	1	4	1	1.67	(1.51)
	Hose crimp and nozzle length equal to ID of pipe?	1	4	1	2	2	2	2.00	(1.10)
	Hydraulic concerns addressed - can lance machine be used?	0	4	1	0	4	0	1.50	(1.97)
	End of tubes cleaned with rigid lance	5	4	2	1	6	4	3.67	(1.86)
	Correct diameter lance used	5	4	2	2	3	2	3.00	(1.26)
	Proper stinger is used	5	4	2	1	4	4	3.33	(1.51)

Department	Pinpoint	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5	Rater 6	*M*	(SD)
	Foot shield and shin guards used properly	5	4	2	1	3	4	3.17	(1.47)
	Overhead obstruction identified	4	2	2	1	4	1	2.33	(1.37)
	Safe lancing technique used	2	4	2	1	4	0	2.17	(1.60)
	Safe distance from nozzle (2 feet)	2	4	2	3	5	2	3.00	(1.26)
	Both hands on lance	3	4	2	4	5	4	3.67	(1.03)
	Safe lancing technique used	4	4	2	1	4	2	2.83	(1.33)
	Correct size collet installed	0	4	1	1	4	4	2.33	(1.86)
	Control Box in safe location	1	3	0	0	2	2	1.33	(1.21)
	Hose stop installed	1	4	2	1	4	2	2.33	(1.37)
	Wearing PPE 10 ft of equip being cleaned	6	5	3	5	5	2	4.33	(1.51)
C (Employee)	Started loosening back bolts first while taking off flange?	6	6	4	4	5	5	5.00	(0.89)
	If valve opening needed to be cleaned, operator did so without being in direct path? (e.g., arm fully extended, body to the side, face away from opening)	6	7	6	7	6	6	6.33	(0.52)
	Ground operator communicated to nitrogen operator that all valves are set in the line (opened/closed)?	5	5	5	5	6	4	5.00	(0.63)
	Correct tool used for task? (instead of using body or an improvised tool; like a screwdriver to rip off a tag or channel locks to loosen bolts)	5	3	2	2	4	4	3.33	(1.21)
	Started loosening back bolts first while taking off flange?	6	5	6	4	5	5	5.17	(0.75)
	Put on (PPE) prior to touching bolts with hand?	6	6	5	6	6	5	5.67	(0.52)
	If bolt is too hot, took break to avoid heat?	7	5	4	3	7	6	5.33	(1.63)
	Set up air horn prior to opening sample valve?	6	5	6	4	5	5	5.17	(0.75)
	Opened sample collector without being in direct path of opening? (e.g., arm fully extended, body to the side, face away from opening)	6	5	4	6	6	5	5.33	(0.82)

Department	Pinpoint	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5	Rater 6	*M*	(SD)
	Operator was in control of sample valve opening? (e.g., opened at a slow pace)	6	4	2	5	4	3	4.00	(1.41)
	(Valve Operator) Stood on side of valve opening?	4	4	2	1	5	4	3.33	(1.51)
	Operator used engineered tool to rod dumpster?	5	3	3	3	4	4	3.67	(0.82)
	Pushed rod into dumpster while standing to side? (not directly behind)	5	4	6	5	5	4	4.83	(0.75)
	If required excessive force, were appropriate measures taken to mitigate force? (asking for help, taking a break, tool selection, etc.)	7	5	7	2	7	4	5.33	(2.07)
	Put venting hose over valve opening prior to venting pressure?	6	6	6	4	6	5	5.50	(0.84)
	Used three points of contact while using foot to lift turn valve? Arms must be extended to opposite locations.	7	6	7	6	6	6	6.33	(0.52)

Note. Table displaying the raters scoring of pinpoint criteria per pinpoint. Pinpoints were rated from 0-7 based on the seven pinpointing criterion. Pinpoints receive one point for each of the criteria met.

Table 4

Pinpoint Criteria Mean and Standard Deviation by Checklist

Department	Baseline		Task-specific	
	Mean	(SD)	Mean	(SD)
A	2.36	(1.85)	1.96	(1.61)
B	2.45	(1.74)	2.31	(1.62)
C	0.84	(1.20)	4.96	(1.34)

Note. Mean and standard deviation were calculated with all six raters pinpointing scores across all pinpoints for each checklist.

Table 5

Pinpoint Categorization into prior Baseline Behavior Categories

Behavior Categories	Task-Specific Pinpoint	Department
Personal Protective Equipment	Wearing proper PPE when needed?	A
	Fall protection is being used	B
	Foot shield and shin guards used properly	B
	Harness is worn correctly	B
	PPE (HB policy followed)	B
	Wearing PPE 10 ft of equip being cleaned	B
	Put on (PPE) prior to touching bolts with hand?	C
Body Use	Aware of pinch points and hand traps?	A
	Burrs or sharp edges present?	A
	Body positioned correctly?	A
	Correct lifting technique?	A
	Both hands on lance	B
	Safe distance from nozzle (2 feet)	B
	Safe lancing technique used	B
	Safe lancing technique used	B
	Used 3 -points of contact	B
	(Valve Operator) Stood on side of valve opening?	C
	If valve opening needed to be cleaned, operator did so without being in direct path? (e.g., arm fully extended, body to the side, face away from opening)	C
	Opened sample collector without being in direct path of opening? (e.g., arm fully extended, body to the side, face away from opening)	C
	Pushed rod into dumpster while standing to side? (not directly behind)	C
	Started loosening back bolts first while taking off flange?	C
	Used three points of contact while using foot to lift turn valve? Arms must be extended to opposite locations.	C
	Operator was in control of sample valve opening? (e.g., opened at a slow pace)	C
Tools & Equipment	Clamps, t-nuts, etc. in good shape?	A
	Has anything been improvised or fixed to make due, to get job done?	A
	Jaws / fixtures set properly, including the safety stops?	A
	Lifting equipment stored properly?	A

Behavior Categories	Task-Specific Pinpoint	Department
	Machine functioning properly?	A
	Machine guards in place?	A
	Correct tool used for task?	A
	Lifting devices inspected prior to use?	A
	Proper lifting devices used? Quick sleeves used?	A
	End of tubes cleaned with rigid lance	B
	Equipment flushed to check for debris and blown out orifices	B
	Equipment is inspected	B
	Flange and pipe ends cleaned with rigid lance	B
	Harness is inspected before use? What did you inspect?	B
	Is the Rig level	B
	Lance/hose/fitting/nozzle inspection	B
	Safety Equipment worn correctly	B
	Truck, pump, and hoses inspected daily?	B
	"Hands Free" equipment set up correctly	B
	Can “Hands Free" equipment be used	B
	Can backout device make job safer	B
	Channel-locks appropriate tool	B
	Correct diameter lance used	B
	Correct size collet installed	B
	Crescent wrench appropriate tool	B
	Hose crimp and nozzle length equal to ID of pipe?	B
	Hose stop installed	B
	Proper stinger is used	B
	Proper stinger length per diameter of pipe	B
	Pump Operator wearing his headset	B
	Whip checks used properly	B
	Correct tool used for task? (instead of using body or an improvised tool; like a screwdriver to rip off a tag or channel locks to loosen bolts)	C
	Operator used engineered tool to rod dumpster?	C
	Put venting hose over valve opening prior to venting pressure?	C
	Set up air horn prior to opening sample valve?	C
Policies and Procedures	Bystanders aware and at a safe distance?	A
	Can employee perform this function safely without assistance?	A
	Dump Gun Operator Position - Line of sight with lance operator	B
	Pump Operator on the Rig	B
	Confined Space Permit fill out correctly	B
	Current temperature of equipment	B

Behavior Categories	Task-Specific Pinpoint	Department
	Hot Work Permit filled out correctly	B
	Safe Work Permits filled out correctly	B
	Blue HP tape around work area	B
	Control Box in safe location	B
	Using personnel lift to perform task? (JLG) 2 trained lift operators?	B
	Aware of the possibility of stored/trapped energy	B
	Can worker be “out of the line of fire”	B
	Changed operations based on weather conditions	B
	Hydraulic concerns addressed - can lance machine be used?	B
	Jointly identified equip in field	B
	Overhead obstruction identified	B
	Stored energy concerns addressed	B
	What could go wrong? What would you do then?	B
	What energy is present? (Steam, line plugged, head pressure)	B
	Location & tested shower and eye wash	B
	Planned escape route	B
	Zone, Temporary Haven, EAP identified	B
	Ground operator communicated to nitrogen operator that all valves are set in the line (opened/closed)?	C
Environment and Housekeeping	>1 can of aerosol product at work station?	A
	Chemical concerns?	A
	Coolant contaminated?	A
	Decontamination tag present & correct?	A
	Floor free of coolant & waste oil?	A
	Any trip / slip hazards?	A
	Cutters stored with covers in place?	A
	Equipment / floor free of shavings?	A
	Work table cluttered?	A
	Area clear of tripping hazards, hoses, scrap, equip.	B
	Blast hose routed away from walkway if possible	B
	Scaffolding built correctly to reach equip	B
Positioning of People	Using techniques to minimize excessive force / gripping to manipulate tools and equipment?	A
	Repetitive motion?	A
	Extreme temperature precautions taken	B
	If bolt is too hot, took break to avoid heat?	C
	If required excessive force, were appropriate measures taken to mitigate force? (asking for help, taking a break, tool selection, etc.)	C

Table 6

Pinpoint Categorization of Control Departments' Checklist Items

Behavior Categories	Pinpoint	Department
PPE	Hand Protection	D & E
	Eye/Face Protection	D & E
	Protective Clothing	D & E
	Head Protection	D & E
	Respiratory Protection	D & E
	Hearing Protection	D & E
Body Use	Eyes on Hands	D & E
	Line of Fire / Pinch Points	D & E
	Eyes on Path	D & E
	Body Position (Ergonomics)	D & E
	Hurrying/Rusing	D & E
	Lifting	D & E
Tools and Equipment	Tools and Equipment Condition	D & E
	Tool and Equipment Selection and Use	D & E
	Ventilation	D & E
	Glassware	D & E
Policies and Procedures	Communication	D & E
	Lock Out / Tag Out	D & E
	Permits	D & E
	JSA / Test Method / Operating Procedures	D & E
	Hazard Recognition and Control	D & E
	Knows location of nearest eyewash and shower	D & E
Environment and Housekeeping	Chemical Storage/Disposal/Handling	D & E
	Housekeeping	D & E
	Physical Condition	D & E
Positioning of People	Striking Against Objects	D & E
	Struck by Objects	D & E
	Caught In/On/Between Objects	D & E
	Contacting Temperature Extremes	D & E
	Contacting Electrical Current	D & E
	Overexertion	D & E
	Repetitive Motions	D & E

Table 7

Number of Pinpoints Within Each Categorization by Department

Behavior Categories	Department	Pinpoints
PPE	A	1 (3%)
	B	5 (8%)
	C	1 (6%)
Body Use	A	4 (15%)
	B	5 (8%)
	C	7 (46%)
Tools and Equipment	A	9 (34%)
	B	22 (38%)
	C	4 (26%)
Policies and Procedures	A	2 (7%)
	B	21 (36%)
	C	1 (6%)
Environment and Housekeeping	A	9 (34%)
	B	3 (20%)
	C	0
Positioning of People	A	1 (3%)
	B	1 (1%)
	C	2 (13%)

Note. The percentage of pinpoints per category out of the total checklist pinpoints appears in parentheses.

Table 8

Personal Protective Equipment (PPE) Pinpoints Mean Risk Identification Percentage Across Baseline and Intervention

Department	Baseline	Upper Control Limit	Task-specific	Upper Control Limit
A (Manager)	1.7 (4.1)	14.2	0.0 (0.0)	14.2
B (Manager)	0.0 (0.0)	0.0	3.5 (8.3)	28.4
C (Employee)	0.2 (0.5)	1.8	0.0 (0.0)	1.8
D (Control)	0.1 (0.2)	1.0		
E (Control)	0.2 (0.4)	1.5		

Note. Risk identification is calculated by the total number of at-risk behavior observed divided by the sum of the safe and at-risk behavior responses multiplied by 100 for a percentage. The standard deviation appears in parentheses. The upper control limit is a calculation of three standard deviations.

Table 9

Body Use Pinpoints Mean Risk Identification Percentage Across Baseline and Intervention

Department	Baseline	Upper Control Limit	Task-specific	Upper Control Limit
A (Manager)	0.6 (1.6)	5.5	0.1 (0.5)	5.5
B (Manager)	0.3 (1.5)	4.9	0.0 (0.0)	4.9
C (Employee)	0.5 (1.1)	3.7	9.6 (14.1)	51.9
D (Control)	0.1 (0.3)	1.0		
E (Control)	0.2 (0.6)	2.0		

Note. Risk identification is calculated by the total number of at-risk behavior observed divided by the sum of the safe and at-risk behavior responses multiplied by 100 for a percentage. The standard deviation appears in parentheses. The upper control limit is a calculation of three standard deviations.

Table 10

Tools and Equipment Pinpoints Mean Risk Identification Percentage Across Baseline and Intervention

Department	Baseline	Upper Control Limit	Task-specific	Upper Control Limit
A (Manager)	2.0 (3.6)	12.8	0.3 (0.7)	12.8
B (Manager)	0.5 (2.1)	6.8	18.2 (16.0)	66.3
C (Employee)	0.5 (1.4)	4.6	20.3 (20.7)	82.4
D (Control)	0.2 (2.1)	6.6		
E (Control)	0.2 (0.8)	2.7		

Note. Risk identification is calculated by the total number of at-risk behavior observed divided by the sum of the safe and at-risk behavior responses multiplied by 100 for a percentage. The standard deviation appears in parentheses. The upper control limit is a calculation of three standard deviations.

Table 11

Policies and Procedures Pinpoints Mean Risk Identification Percentage Across Baseline and Intervention

Department	Baseline	Upper Control Limit	Task-specific	Upper Control Limit
A (Manager)	0.7 (1.9)	6.2	0.3 (1.3)	6.2
B (Manager)	0.6 (2.0)	6.6	6.9 (5.7)	24.1
C (Employee)	0.6 (1.1)	3.9	0.0 (0.0)	3.9
D (Control)	0.1 (0.5)	1.7		
E (Control)	0.4 (0.8)	2.8		

Note. Risk identification is calculated by the total number of at-risk behavior observed divided by the sum of the safe and at-risk behavior responses multiplied by 100 for a percentage. The standard deviation appears in parentheses. The upper control limit is a calculation of three standard deviations.

Table 12

Environment and Housekeeping Pinpoints Mean Risk Identification Percentage Across Baseline and Intervention

Department	Baseline	Upper Control Limit	Task-specific	Upper Control Limit
A (Manager)	3.4 (4.8)	17.7	0.9 (2.4)	17.7
B (Manager)	1.7 (4.1)	14.1	0.0 (0.0)	14.1
C (Employee)	0.4 (1.0)	1.8		
D (Control)	0.6 (1.5)	5.0		
E (Control)	1.6 (3.8)	12.8		

Note. Risk identification is calculated by the total number of at-risk behavior observed divided by the sum of the safe and at-risk behavior responses multiplied by 100 for a percentage. The standard deviation appears in parentheses. The upper control limit is a calculation of three standard deviations. Department C did not have any pinpoints in the environment and housekeeping category during intervention.

Table 13

Positioning of People Pinpoints Mean Risk Identification Percentage Across Baseline and Intervention

Department	Baseline	Upper Control Limit	Task-specific	Upper Control Limit
A (Manager)	0.9 (4.4)	14.2	0.0 (0.0)	14.2
B (Manager)	0.0 (0.0)	0.0	0.0 (0.0)	0.0
C (Employee)	0.3 (0.7)	2.5	0.0 (0.0)	2.5
D (Control)	0.1 (0.4)	1.1		
E (Control)	0.2 (0.6)	1.9		

Note. Risk identification is calculated by the total number of at-risk behavior observed divided by the sum of the safe and at-risk behavior responses multiplied by 100 for a percentage. The standard deviation appears in parentheses. The upper control limit is a calculation of three standard deviations.

Table 14

Rate of Action Items Created and By Source

Department	Baseline		Task-specific	
	Observation	Other Source	Observation	Other Source
A	0.0	8.7	0.0	2.3
B	0.0	7.0	0.0	3.9
C	0.0	0.1	1.8	0.00
D	0.0	0.5		
E	0.0	0.2		

Note: When employees requested a safety action item on their behavioral checklist, these action items are listed under observation source. Other source includes action items that are created from injuries, audits, and equipment failures. Rates were calculated by taking the total number of action items, divided by the total number of weeks.

Table 15

Injuries by Phase and Department

Department	Baseline	Task-specific
	Injuries	Injuries
A	12 injuries over 67 weeks	2 injuries over 22 weeks
B	29 injuries over 72 weeks	1 injury over 16 weeks
C	3 injuries over 78 weeks	0 injuries over 11 weeks
D	4 injuries 90 over weeks	
E	7 injuries 90 over weeks	

Figures

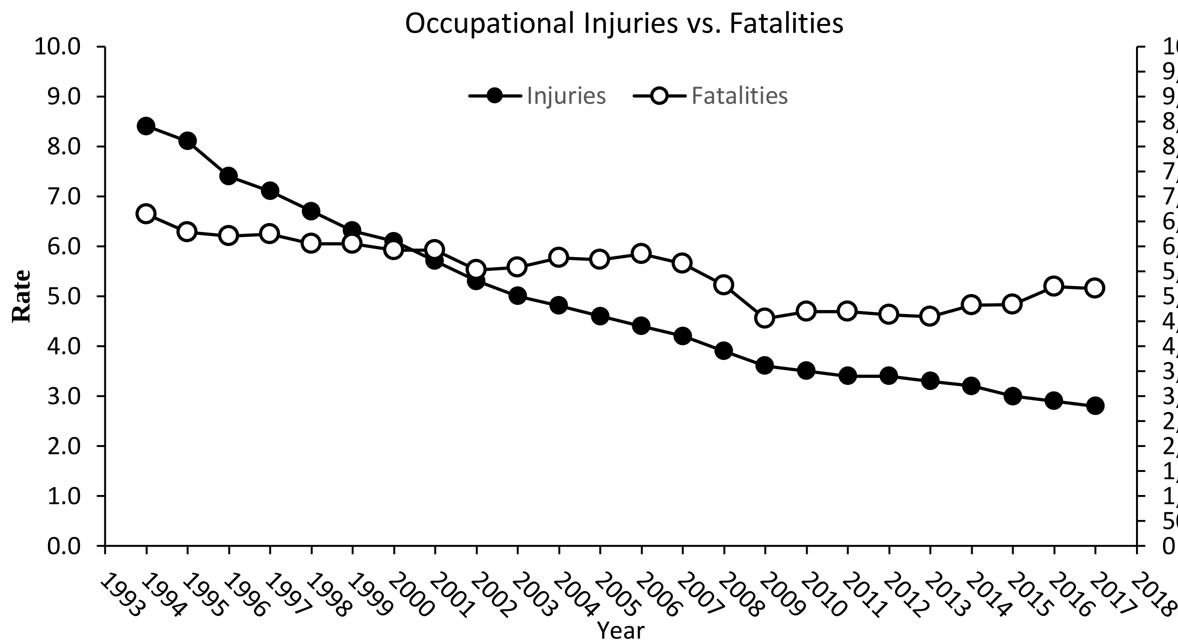


Figure 1. Occupational injuries per 100 employees (OSHA recordable) compared to annual number of fatalities in the United States. Filled circles represent the annual OSHA rate in the United States. Open circles represent the annual number of fatalities in the United States (USLD, BLS, 2018).

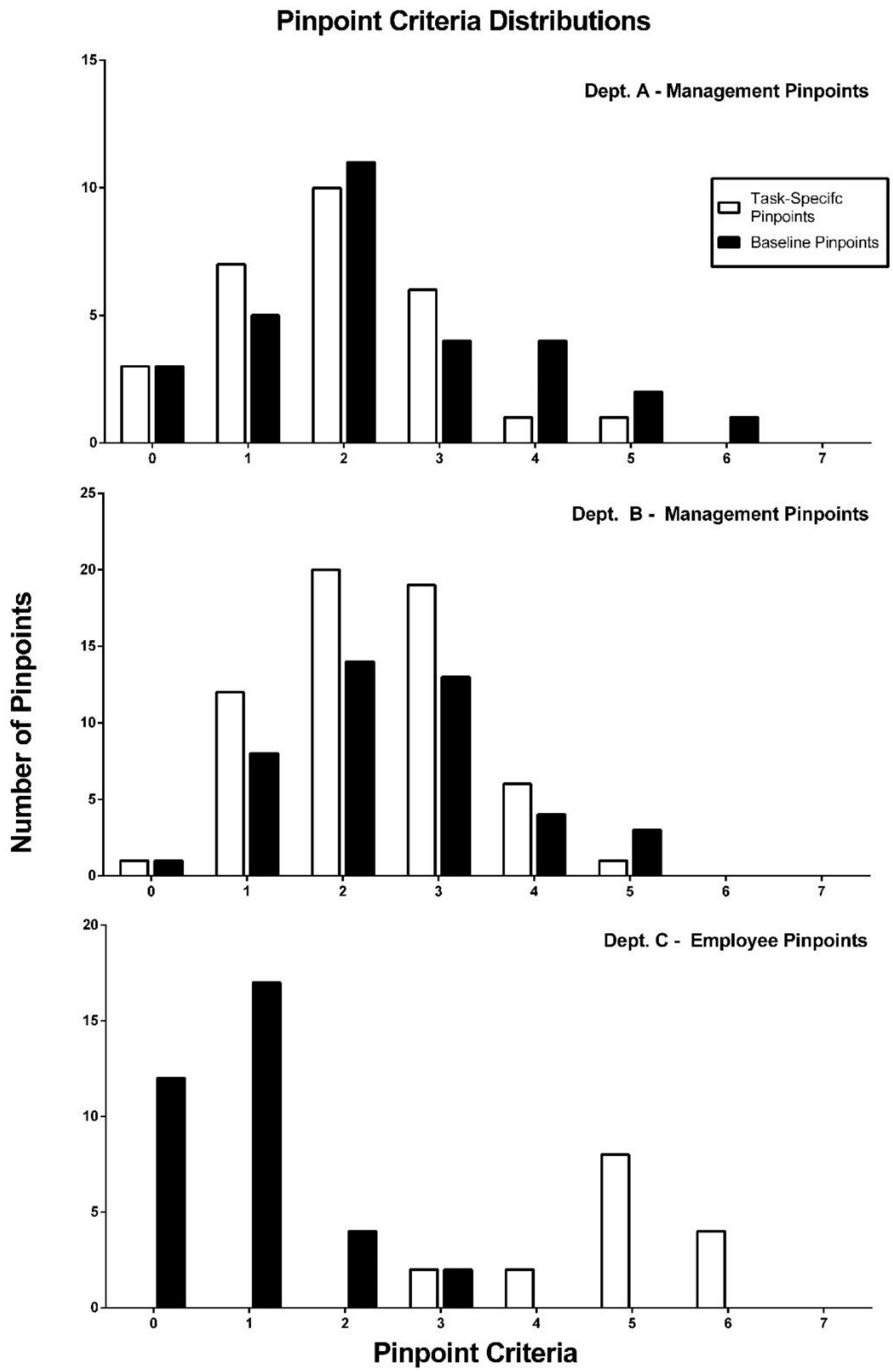


Figure 2. Distribution of average rater pinpoint criterion scores for each Department. Filled bars represent ratings of pinpoints appearing in baseline checklists. Clear bars represent ratings of pinpoints appearing in the new task-specific checklist.

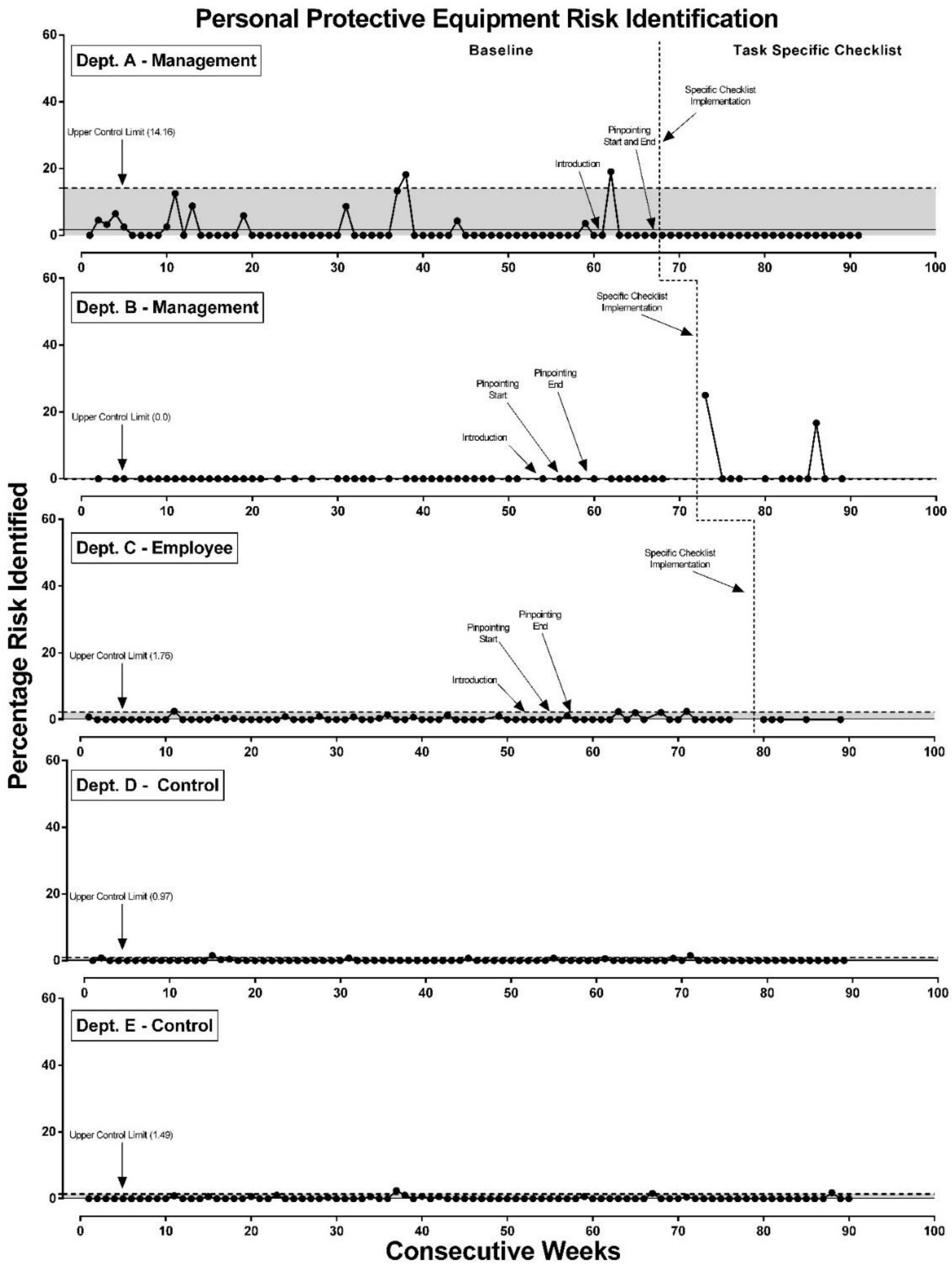


Figure 3. Weekly aggregate of percentage of PPE categorized risk pinpoints identified per department. Solid line indicates the mean percentage risk during baseline. Dashed horizontal lines indicate three sigma units during each departments baseline. Shaded area indicates three sigma units above and below the mean. Vertical dashed line indicates phase change from baseline to task-specific checklist.

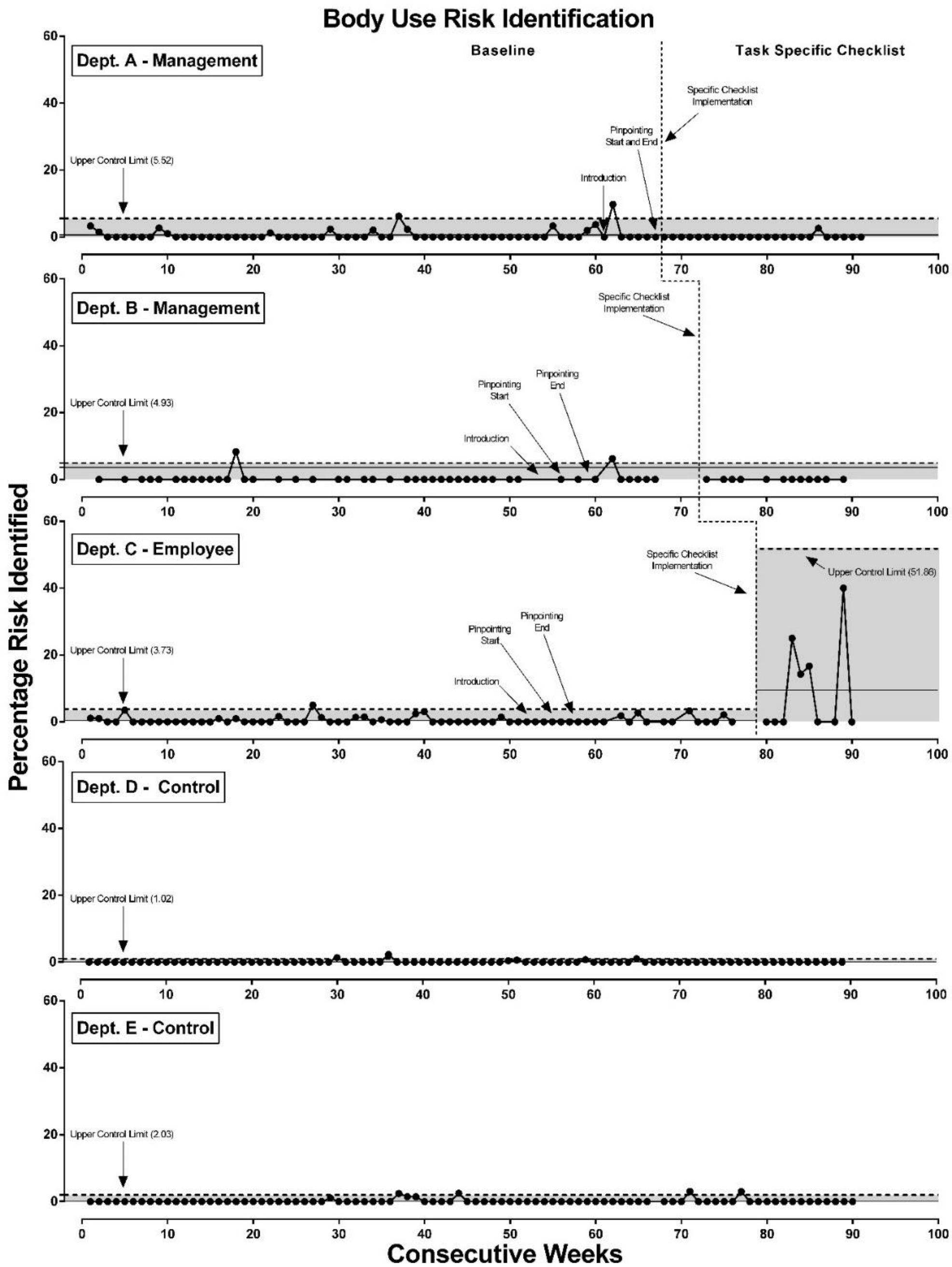


Figure 4. Weekly aggregate of percentage of Body Use categorized risk pinpoints identified per department. Solid line indicates the mean percentage risk during baseline. Dashed horizontal lines indicate three sigma units during each departments baseline. Shaded area indicates three sigma units above and below the mean. Vertical dashed line indicates phase change from baseline to task-specific checklist.

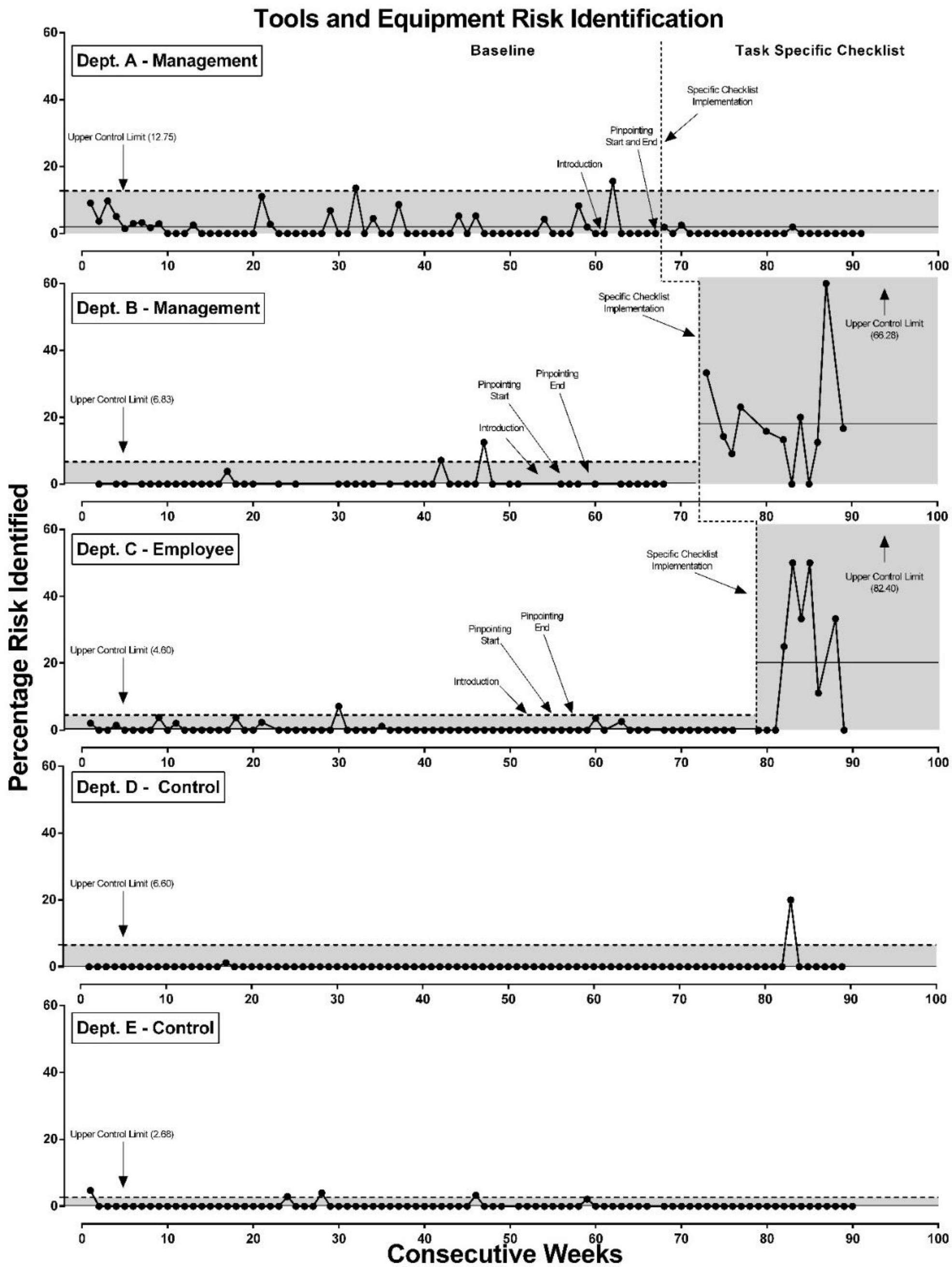


Figure 5. Weekly aggregate of percentage of tools and equipment categorized risk pinpoints identified per department. Solid line indicates the mean percentage risk during baseline. Dashed horizontal lines indicate three sigma units during each departments baseline. Shaded area indicates three sigma units above and below the mean. Vertical dashed line indicates phase change from baseline to task-specific checklist.

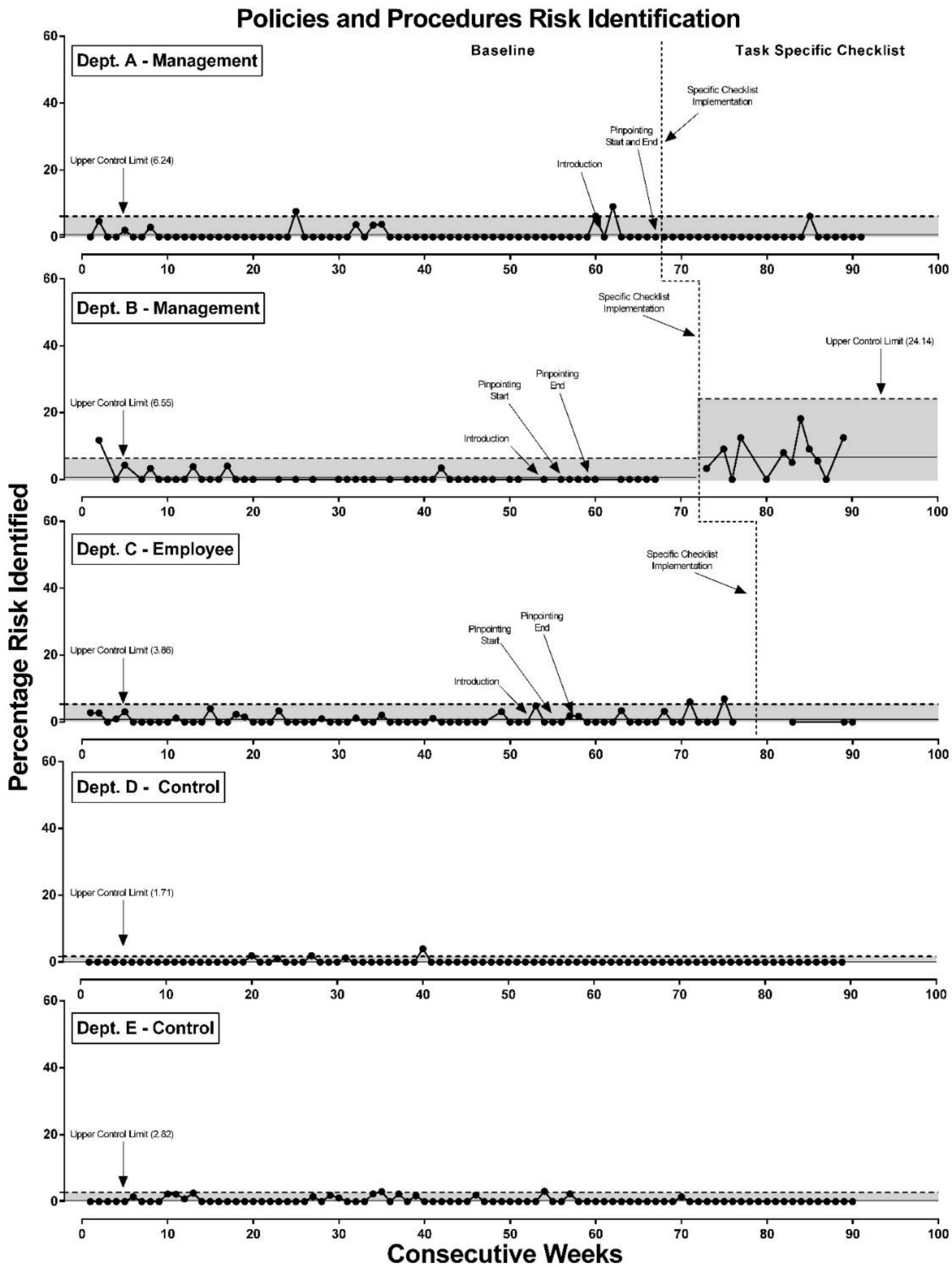


Figure 6. Weekly aggregate of percentage of policies and procedures categorized risk pinpoints identified per department. Solid line indicates the mean percentage risk during baseline. Dashed horizontal lines indicate three sigma units during each departments baseline. Shaded area indicates three sigma units above and below the mean. Vertical dashed line indicates phase change from baseline to task-specific checklist.

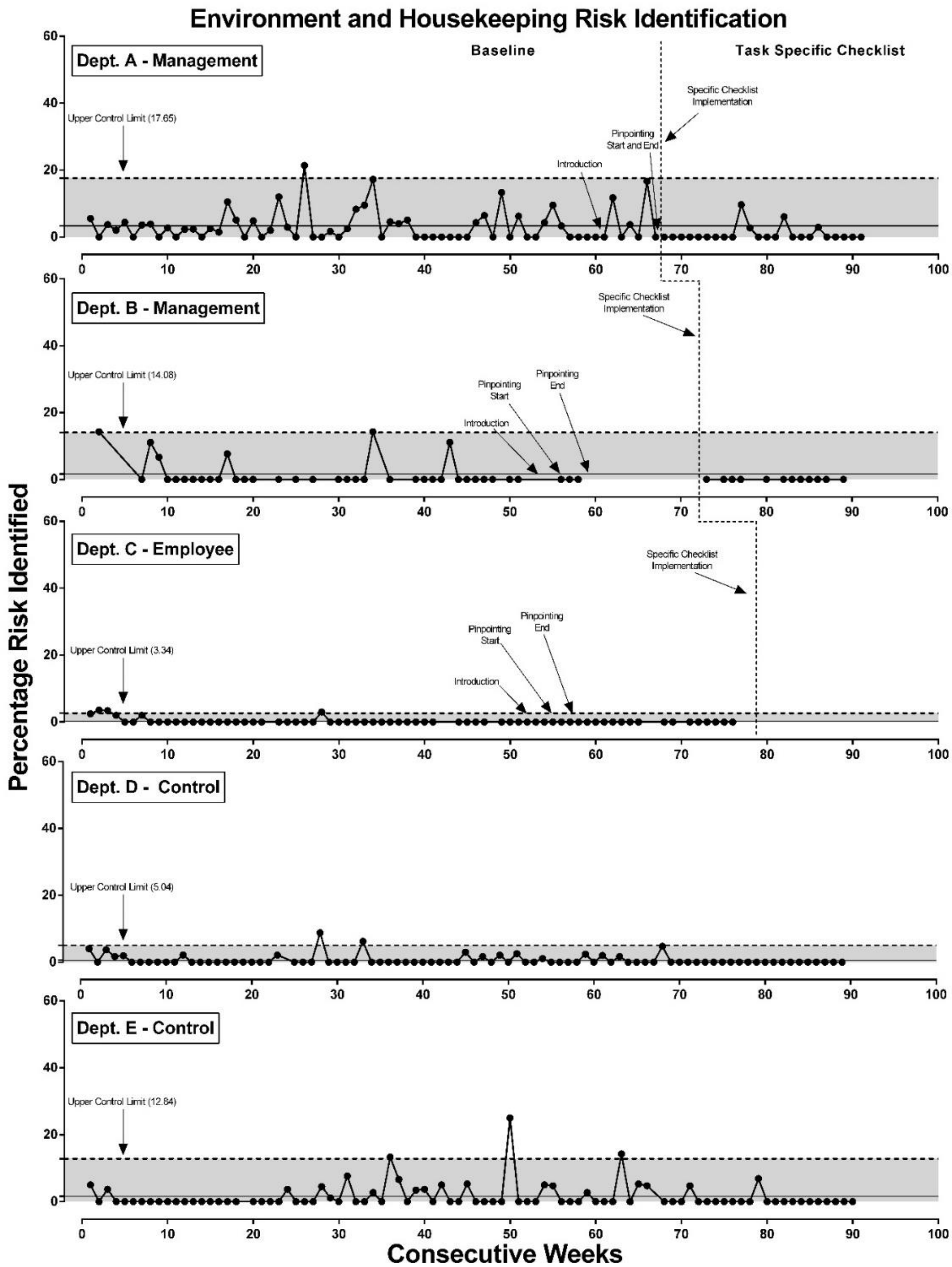


Figure 7. Weekly aggregate of percentage of environment and housekeeping categorized risk pinpoints identified per department. Solid line indicates the mean percentage risk during baseline. Dashed horizontal lines indicate three sigma units during each departments baseline. Shaded area indicates three sigma units above and below the mean. Vertical dashed line indicates phase change from baseline to task-specific checklist.

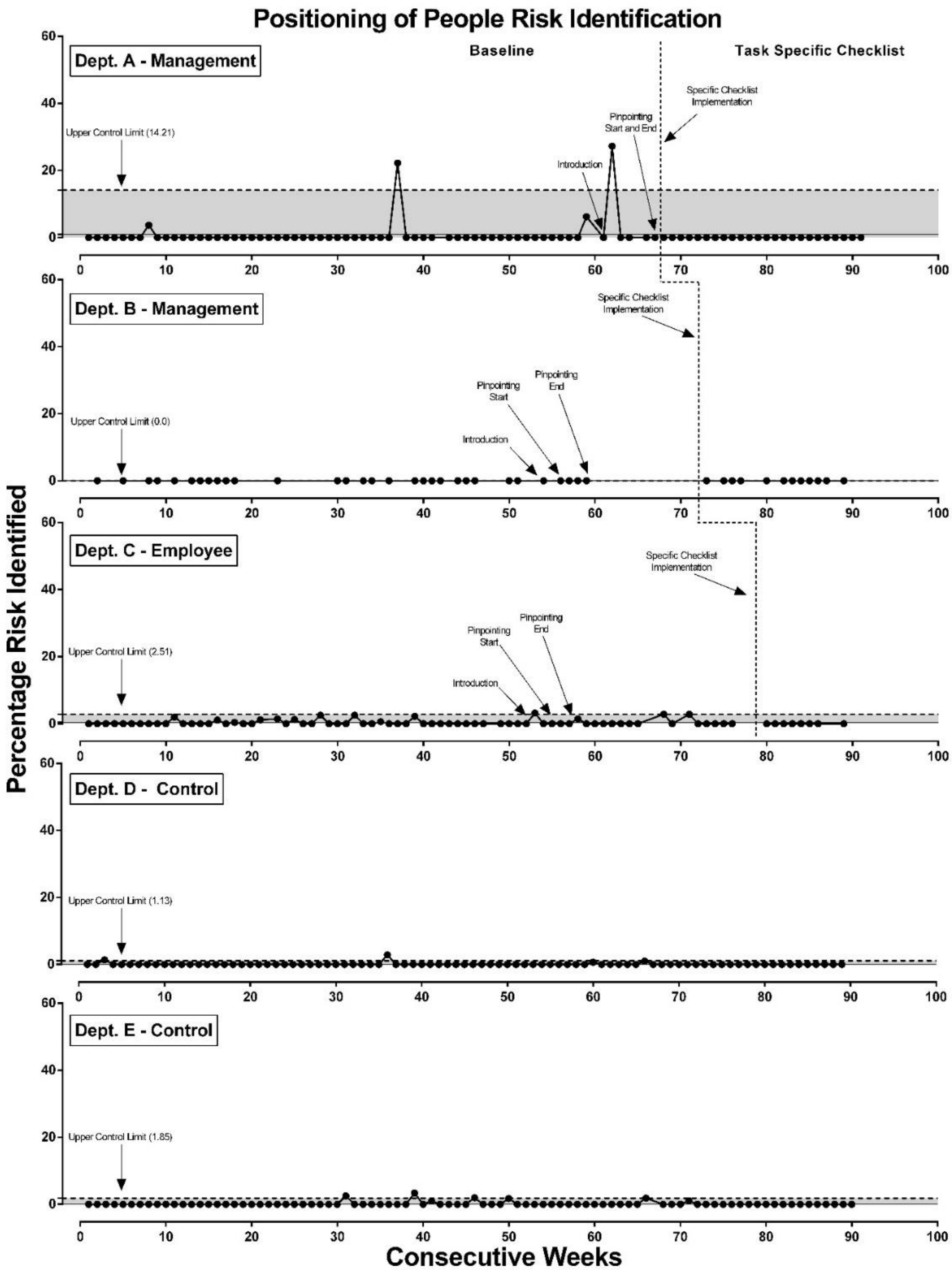


Figure 8. Weekly aggregate of percentage of positioning of people categorized risk pinpoints identified per department. Solid line indicates the mean percentage risk during baseline. Dashed horizontal lines indicate three sigma units during each departments baseline. Shaded area indicates three sigma units above and below the mean. Vertical dashed line indicates phase change from baseline to task-specific checklist.

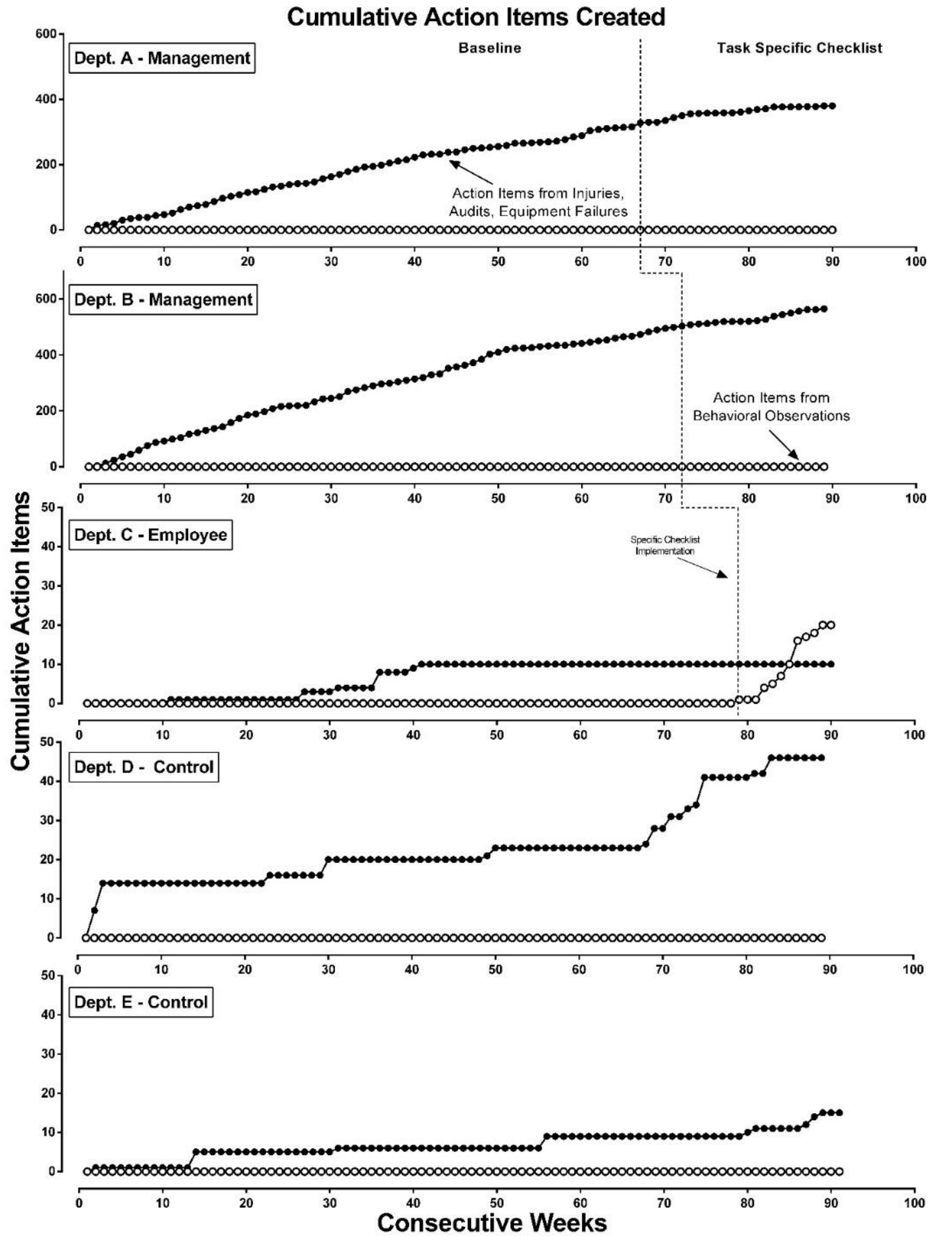


Figure 9. Cumulative action items created for all departments. The y axis measures the total number of action items created since the start of the study. The x axis displays consecutive weeks. Each action item created, increases the data on the y axis. A steeper slope indicates a greater rate of action items being created, whereas a gradual slope represented a lesser rate. Filled circles indicate the number action items created from injuries, audits, and equipment failures. Open circles represent action items that resulted from behavioral observations.

Appendix A

Data and Materials Distribution Agreement

Safety Analytics Project
Data and Materials Distribution Agreement

This Data and Materials Distribution Agreement (hereinafter "Agreement"), effective as of **March 26, 2018 ("Effective Date")**, by and between **Eastman Chemical Company** (hereinafter referred to as "Eastman"), and **Appalachian State University** (hereinafter referred to as "Appalachian State"), an educational institution of the State of North Carolina, on behalf of **Drs. Shawn Bergman and Timothy Ludwig** (hereinafter referred to as the "Principal Investigators" of the propose research project).

The undersigned parties hereby enter into this Data and Materials Distribution Agreement (DMDA) as of the date specified on the final page hereof.

DEFINITIONS
For purposes of this agreement, the terms below have the following meaning:

"Data" refers to any and all study data, information, and associated records obtained directly from Eastman.

"Personally Identifying Information" refers to information that could be used to identify an individual's identity.

"Materials" refers to Eastman information and materials, including but not limited to HR personnel data (e.g., selection tests, hiring decisions, and performance management data) provided to the Recipient.

"Resultant Data" refers to data derived in whole or in part by Recipient from Data and/or Materials provided under this DMDA.

"Eastman Personnel" refers to the personnel of the Eastman authorized to provide the University with data and materials and who are authorized review and provide feedback on the presentation and/or publication of project's results.

"Research Project" refers to the project described in section 4 below.

"Recipient" refers to the research investigators at Appalachian State receiving access to the Eastman Study Data and/or Materials requested for the Research Project identified in section 3 below.

"Principal Investigator (PI)" refers to the Research Project directors for the Recipient.

TERMS AND CONDITIONS
It is mutually agreed as follows:

1. **Materials.** Eastman, in its sole discretion, agrees to transfer to Recipient the Materials described as follows, for use by the Recipient's PI to conduct the Research Project as summarized in section 4 below:
    a. **Not applicable.**

2. **Data.** Eastman, in its sole discretion, agrees to provide Recipient with Data described as follows: Safety data from Eastman's safety data collection systems with PII redacted.

3. Notwithstanding Paragraph 15, below, Eastman may terminate its agreement to provide the above Materials and Data at any time with 30 days prior notice to Appalachian State.

4. **Research Project.**
   4.1 These Materials and Data will be used by Recipient's PI solely in connection with the Research Project, as named and described below:

Project title: Safety Analytics Data Audit and Phase I Investigation

Project description: Eastman's HSE program assesses a number of factors related to environmental and worker safety. While this information has been useful in helping Eastman monitor and manage safety risks, full potential of the information collected may not be realized. More specifically, data analytics can use the information collected by Eastman to identify the most effective response to unplanned events and leading indicators to direct resources that optimally mitigate risks in the future. The project is to investigate the efficacy of data analytics to achieve these results.

   4.2 This DMDA covers only the Research Project cited in section 4.1 of this DMDA. Recipient must submit a separate DMDA for each Research Project for which Data and/or Materials are requested.

5. **Non-transferability.** This DMDA is not transferable.
   5.1 Recipient and Recipient's PI agree that substantive changes made to the Research Project, and/or appointment by Recipient of another Principal Investigator and/or transfer of Recipient's PI to another institution or other entity to complete the Research Project, require execution of a separate DMDA. Recipient may not distribute Data or Materials to any other individual or entity, regardless of the intended use of such Data or Materials. However, nothing in this section precludes Recipient from publishing results of the Research Project through the usual channels of scientific publication provided that the appropriate approvals have been given by Eastman Personnel, see section 7 below.

6. **Conduct of Research Project.** Recipient's PI is responsible for the conduct of the Research Project and shall be responsible for assuring that any co-investigator(s) comply with the terms of this DMDA.

7. **Publication.** Publication and presentation of the results of the Research Project is allowed.
   7.1 The Recipient's PI is to provide the authorized representative for the Eastman a copy of submission materials ten (10) business days in advance of submission for presentation, oral and written presentation materials (e.g., study write-up, visual aids, and/or slides), fifteen (15) business days in advance of presenting Research Project findings, and any manuscript or other disclosure document twenty (20) business days in advance of submission for publication, in order to permit review and provide comments and feedback, and to ensure compliance with the requirements of this DMDA.
   7.2 At the request of Eastman, the source of the data will be anonymized so the source of the data presented in the publication and presentation is not revealed.
   7.3 At the request of Eastman, data presented in any publication and presentation will be standardized (e.g., data will be presented in terms of z-scores or mean-centered)

so that averages are presented as zeros, the absolute levels of the values of the data cannot be determined, and the relationships between variables and concepts are retained.

7.4 The Recipient may not submit or present any results of the Research Project attributed to Eastman without allowing Eastman review and provide comments and feedback by Eastman Personnel.

8. **Non-Identification.** Recipient and Recipient's PI agree that Materials and/or Data will not be used, either alone or in conjunction with any other information, in any effort to determine the individual the PII of any of the participants from whom Data and/or Materials were obtained or derived.

   8.1 Eastman will not share Personally Identifying Information ("PII") with the Recipient. Data provided to the Recipient and Recipient's PI will have PII removed.

   8.2 In the event that any PII is discovered in the Data or Materials, the Recipient and Recipient's PI will remove the PII information from the Data or Materials and report the issue immediately to Eastman Personnel.

9. **Use Limited to Research Project.** Recipient and Recipient's PI agree that Materials, their progeny, or derivatives thereof, and Resultant Data will not be used in any experiments or procedures unless said experiments or procedures are disclosed and approved as part of the Research Project.

10. **No Distribution.** Recipient and Recipient's PI agree to retain control over Data, Materials and their progeny, and derivatives thereof. To the extent permitted by North Carolina law, Recipient and Recipient's PI further agree not to transfer Data, Materials and their progeny, and derivatives thereof, with or without charge, to any other entity or individual, unless required to disclose pursuant to law, regulation, public records act request, subpoena or court order.

11. **Resultant Data to be Provided to Eastman.** Recipient and Recipient's PI agree to provide Eastman with a report at least every twelve (12) months during the term of this DMDA. The report shall include a description of the activities performed and Resultant Data obtained during the twelve (12) months before the reporting date. Recipient and Recipient's PI agree that Eastman may distribute all such Resultant Data to requesting parties.

12. **Recipient's Compliance with Recipient IRB's Requirements.** Recipient certifies that the conditions for use of the Data and/or Materials in conjunction with the Research Project have been reviewed by the Recipient's Institutional Review Board (IRB). Recipient also agrees to report to Recipient's IRB any unanticipated problems or changes in the Research Project that involve additional risks to participants or others. Recipient remains subject to applicable state and local laws and regulations and institutional policies that provide additional protections for human subjects.

13. **Recipient's Responsibility to follow Data Security Best Practices.** Recipient is aware of computer and data security best practices and will follow them for receipt, storage and use of Data and Resultant Data. An example of Appalachian State's data Secure Storage and Sharing guidelines can be found at:
http://security.appstate.edu/resources/policies_and_standards/data_class_guideline

14. **Amendments.** Amendments to this DMDA must be made in writing and signed by authorized representatives of all parties.

15. **Termination.** This DMDA shall terminate at the earliest of: the completion of the Research Project; five (5) years after the effective date of this DMDA; abandonment of the Research Project; or violation by Recipient of any provisions of this DMDA not remedied within 30 days after the date of notice by Eastman of such violation.

16. **Disqualification, Governing Law.** Failure to comply with any of the terms of this DMDA may result in disqualification of Recipient from receiving additional Data and/or Materials. This Agreement shall be governed by the laws of the State of North Carolina.

17. **Prior Distribution Agreements.** By execution of this DMDA, Recipient certifies its good faith belief that it is in compliance with the terms and conditions of all its existing DMDAs with Eastman.

Appalachian State University

By: Charna K Howson

Name: Charna K. Howson

Title: Director, Sponsored Programs

Date: April 27, 2018

Eastman Chemical Company

By: Mark Peal

Name: Mark Peal

Title: Director, Global HSES

Date: 5/7/18

Appendix B

IRB Approval Letter

Appalachian STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
Office of Research Protections
ASU Box 32068
Boone, NC 28608
828.262.2692
Web site: http://researchprotections.appstate.edu
Email: irb@appstate.edu
Federalwide Assurance (FWA) #00001076

To: Matthew Laske
Psychology ,
CAMPUS EMAIL

From: IRB Administration
Date: 9/18/2019
RE: Determination that Research or Research-Like Activity does not require IRB Approval

STUDY #: 20-0051
STUDY TITLE: Identification of At-Risk Behavior Using Targeted Checklists

The IRB determined that the activity described in the study materials does not constitute human subject research as defined by University policy and the federal regulations [45 CFR 46.102 (d or f)] and does not require IRB approval.

This determination may no longer apply if the activity changes. IRB approval must be sought and obtained for any research with human participants.

If you have any questions about this determination, please contact Robin Tyndall at 262-2692; or irb@appstate.edu. Thank you.

Appendix C

Focus Group Meeting Protocol

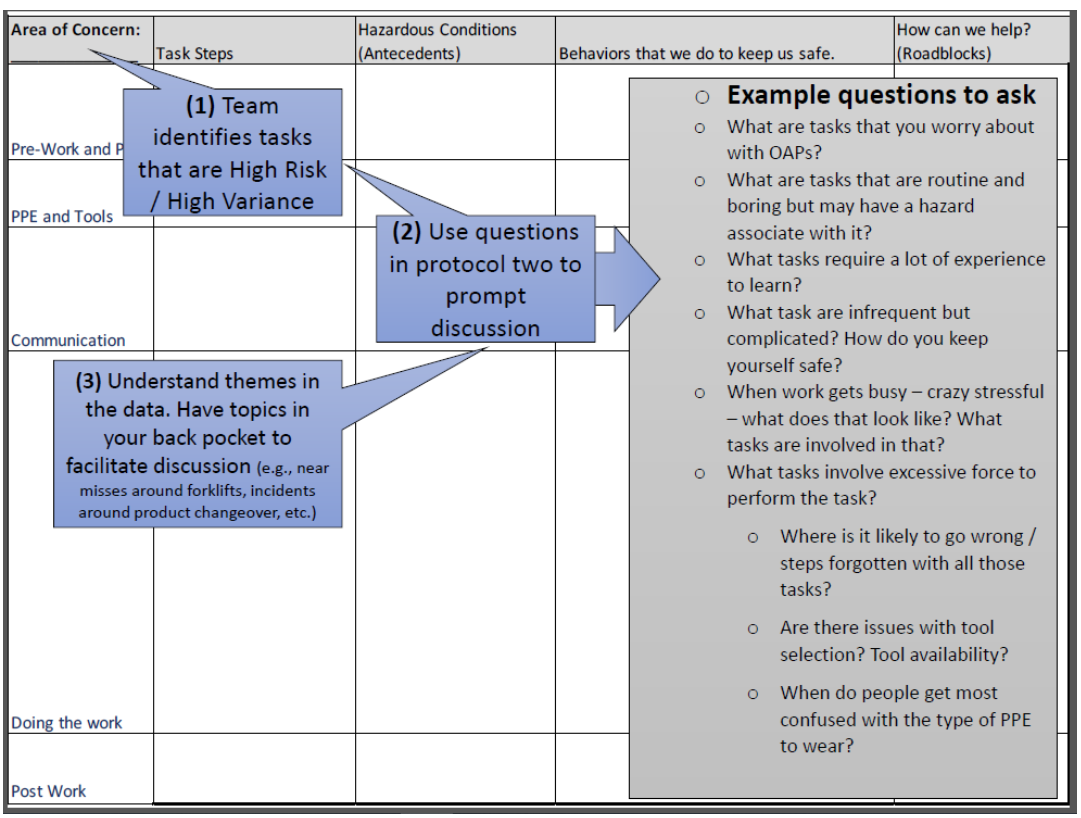
Description: This meeting will last approximately 45-60 minutes, the agenda of the meeting can be found below.

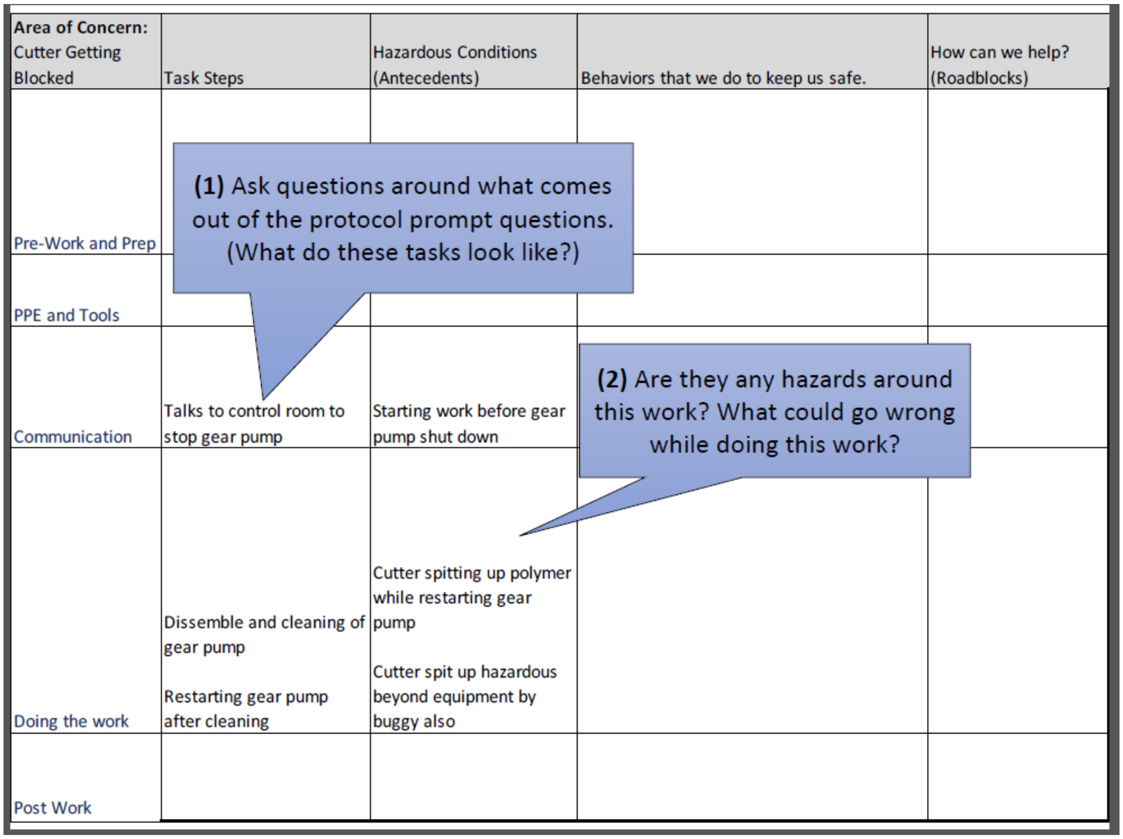
- *State that the purpose of this meeting is to identify critical behaviors that are seen as most important to have conversations around in the field, intervene if something doesn't look okay for the development of the new observation checklist.*
  - *If talking to workers, also discuss how the tool can be used to gather data around the barriers to their job so they can be removed by leadership.*
- Questions that will be asked to facilitate discussion are:
  - What are tasks that you worry about with new employees?
  - What are tasks that are routine and boring but may have a hazard associate with it?
  - What tasks require a lot of experience to learn?
  - What task are infrequent but complicated? How do you keep yourself safe?
  - When work gets busy – crazy stressful – what does that look like? What tasks are involved in that?
  - What tasks involve excessive force to perform the task?
  - What tasks put your body parts at risk of pinch points and sharp edges?
- The following questions will be used as follow ups to inquire further.
  - Where is it likely to go wrong / steps forgotten with all those tasks?
  - Are there issues with tool selection? Tool availability?
  - When do people get most confused with the type of PPE to wear?
  - What PPE is the most uncomfortable?
  - What PPE would you want to see on here, the most critical?
- The manager/workers will then be asked to rate them in terms of critical to safety.
- The manager/workers will then be asked how often they perform these behaviors?
- *Tell the crew/managers that the critical tasks and behaviors discussed will be compared with the data for selection of items on the observation checklist*

Appendix D

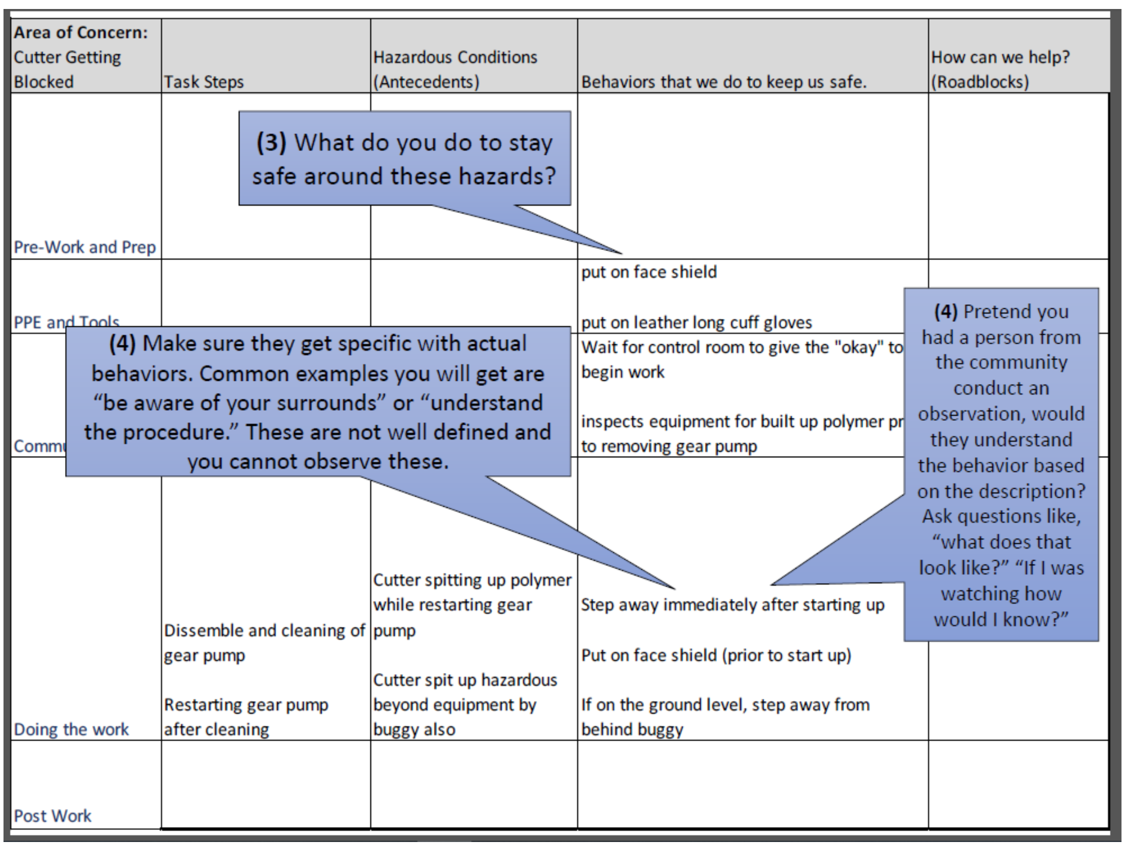
Checklist Development Tool

Area of Concern: ___________	Task Steps	Hazardous Conditions (Antecedents)	Behaviors that we do to keep us safe.	How can we help? (Roadblocks)
Pre-Work and Prep				
PPE and Tools				
Communication				
Doing the work				
Post Work				

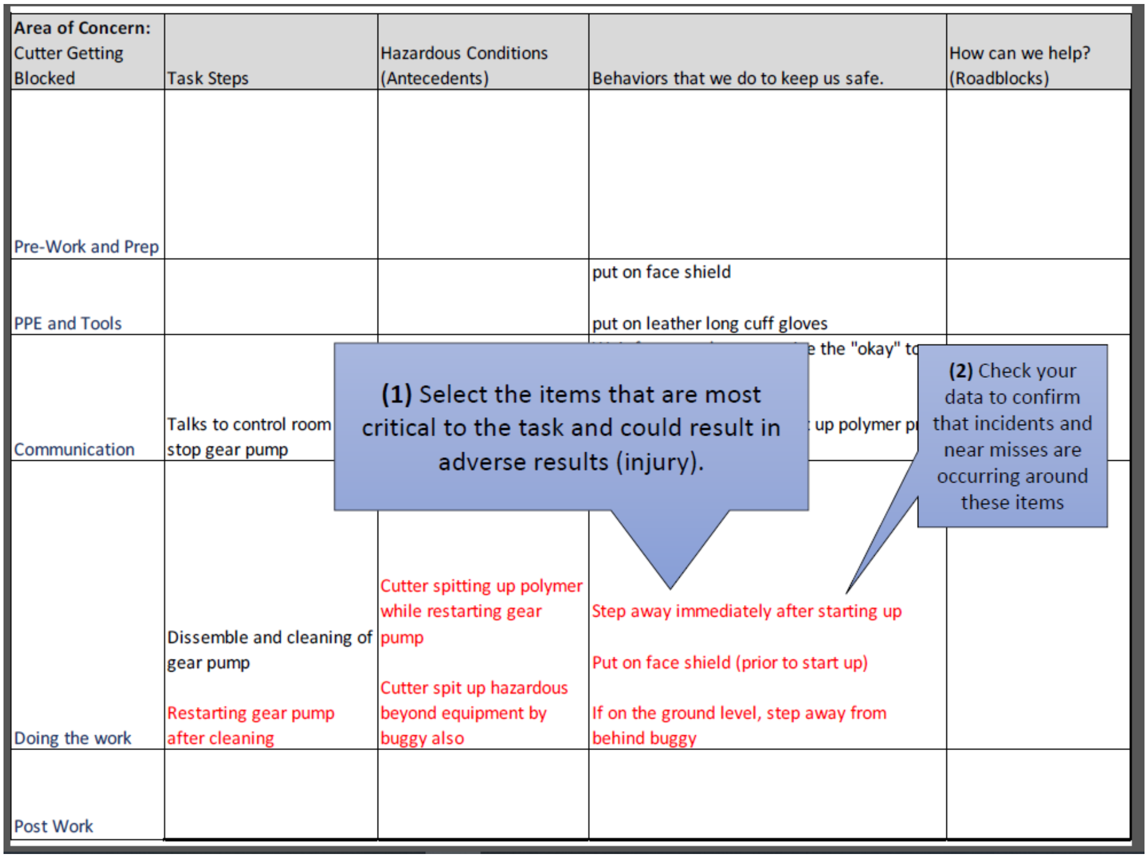




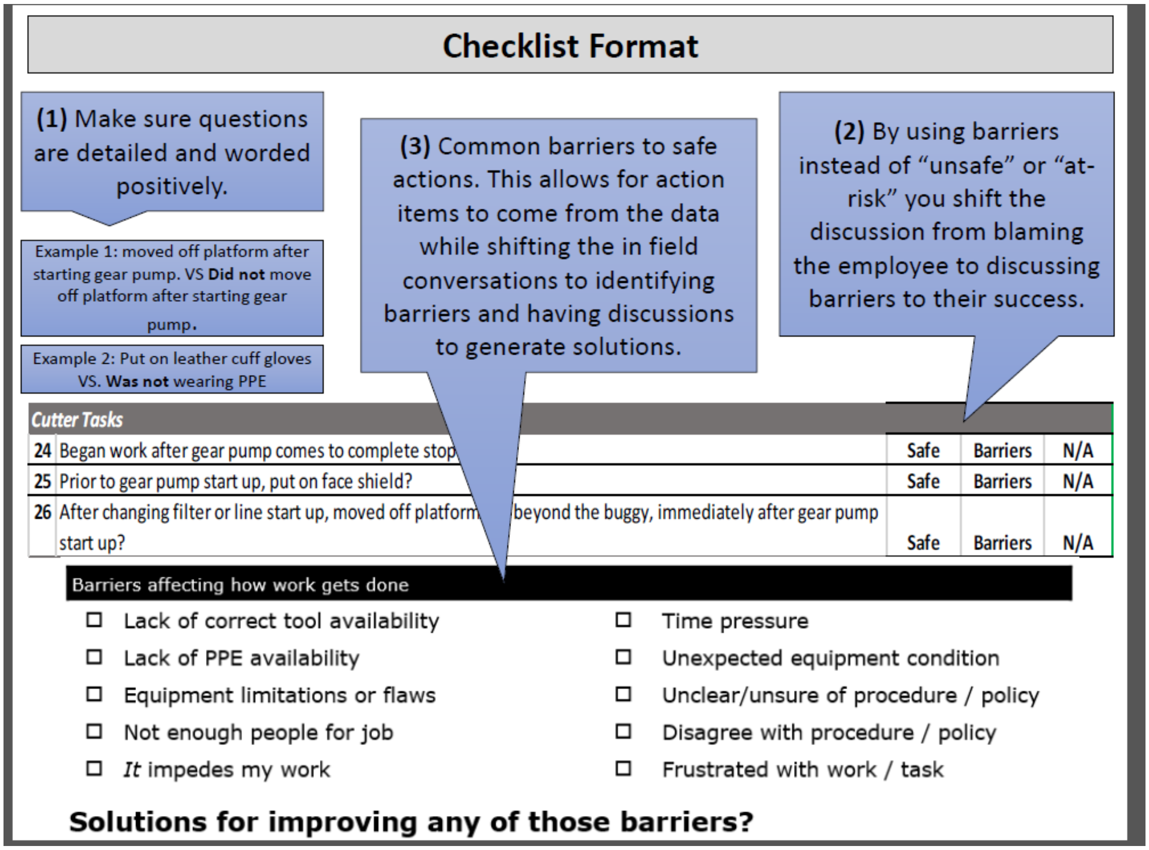
Area of Concern: Cutter Getting Blocked	Task Steps	Hazardous Conditions (Antecedents)	Behaviors that we do to keep us safe.	How can we help? (Roadblocks)
Pre-Work and Prep				
PPE and Tools				
Communication	Talks to control room to stop gear pump	Starting work before gear pump shut down		
Doing the work	Dissemble and cleaning of gear pump Restarting gear pump after cleaning	Cutter spitting up polymer while restarting gear pump Cutter spit up hazardous beyond equipment by buggy also		
Post Work				



Area of Concern: Cutter Getting Blocked	Task Steps	Hazardous Conditions (Antecedents)	Behaviors that we do to keep us safe.	How can we help? (Roadblocks)
Pre-Work and Prep				
PPE and Tools			put on face shield put on leather long cuff gloves	
Comm			Wait for control room to give the "okay" to begin work inspects equipment for built up polymer pr to removing gear pump	
Doing the work	Dissemble and cleaning of gear pump Restarting gear pump after cleaning	Cutter spitting up polymer while restarting gear pump Cutter spit up hazardous beyond equipment by buggy also	Step away immediately after starting up Put on face shield (prior to start up) If on the ground level, step away from behind buggy	
Post Work				

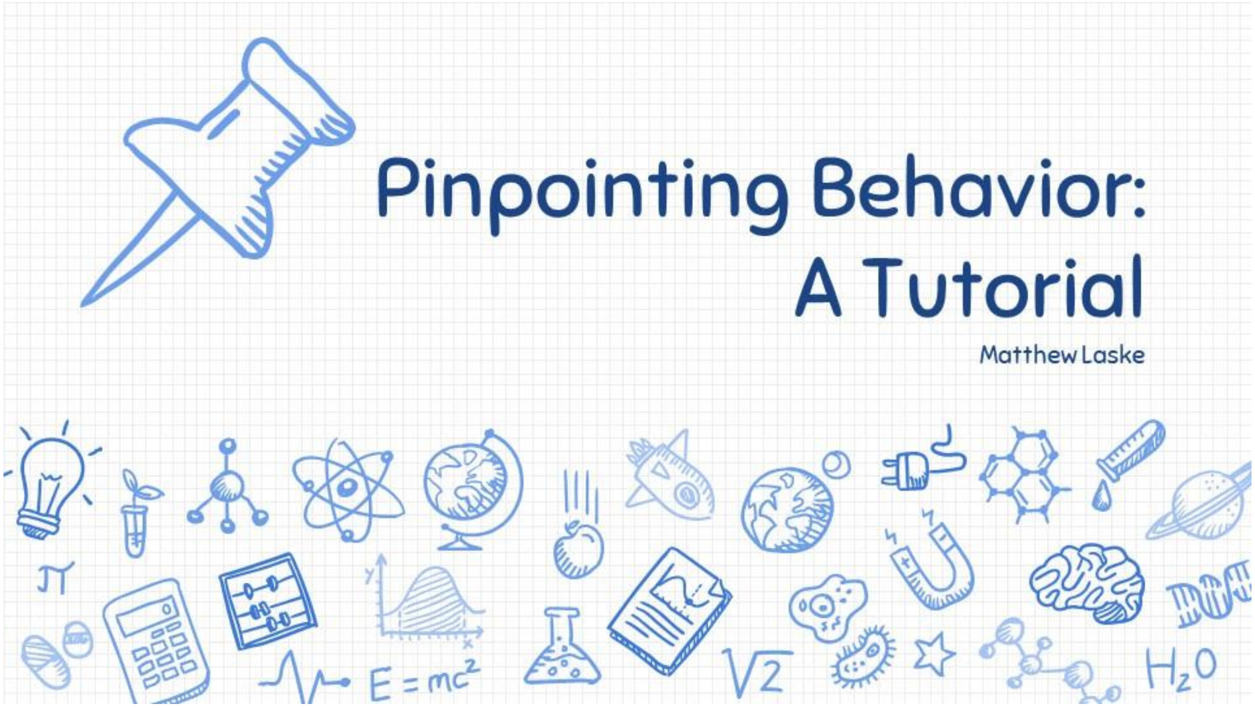


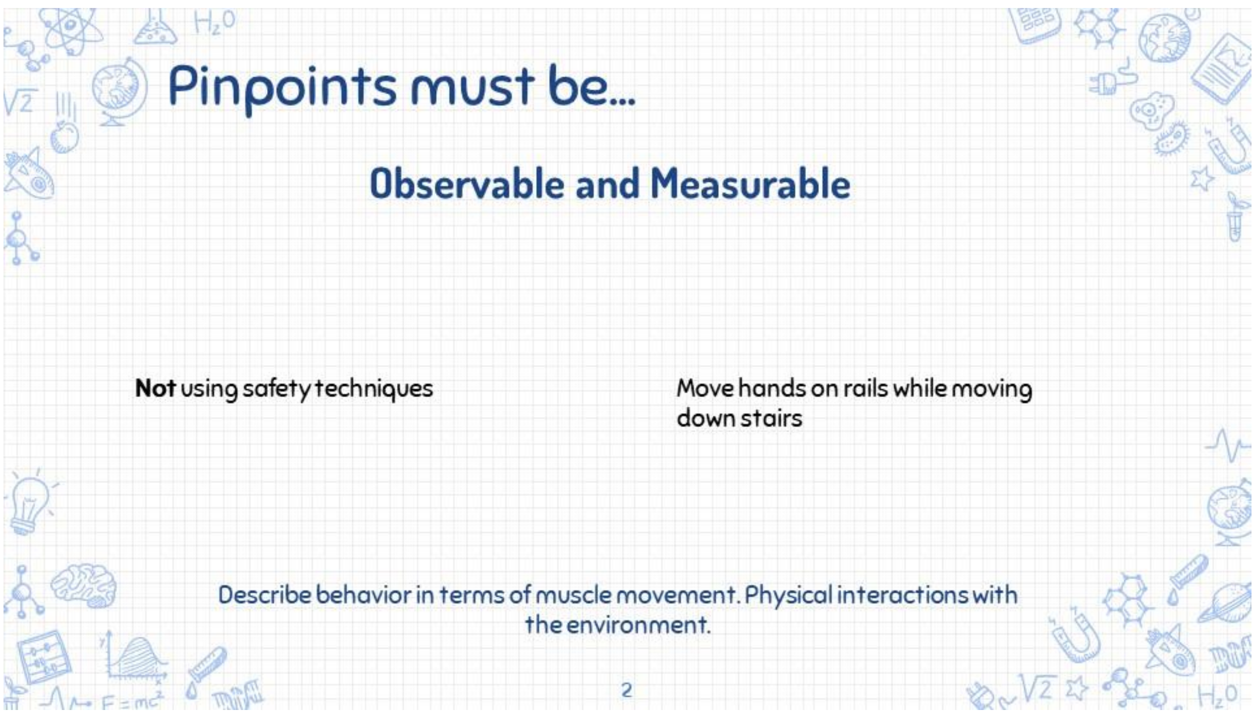
Area of Concern: Cutter Getting Blocked	Task Steps	Hazardous Conditions (Antecedents)	Behaviors that we do to keep us safe.	How can we help? (Roadblocks)
Pre-Work and Prep				
PPE and Tools			put on face shield put on leather long cuff gloves	
Communication	Talks to control room stop gear pump		… the "okay" to … … up polymer p…	
Doing the work	Dissemble and cleaning of gear pump Restarting gear pump after cleaning	Cutter spitting up polymer while restarting gear pump Cutter spit up hazardous beyond equipment by buggy also	Step away immediately after starting up Put on face shield (prior to start up) If on the ground level, step away from behind buggy	
Post Work				

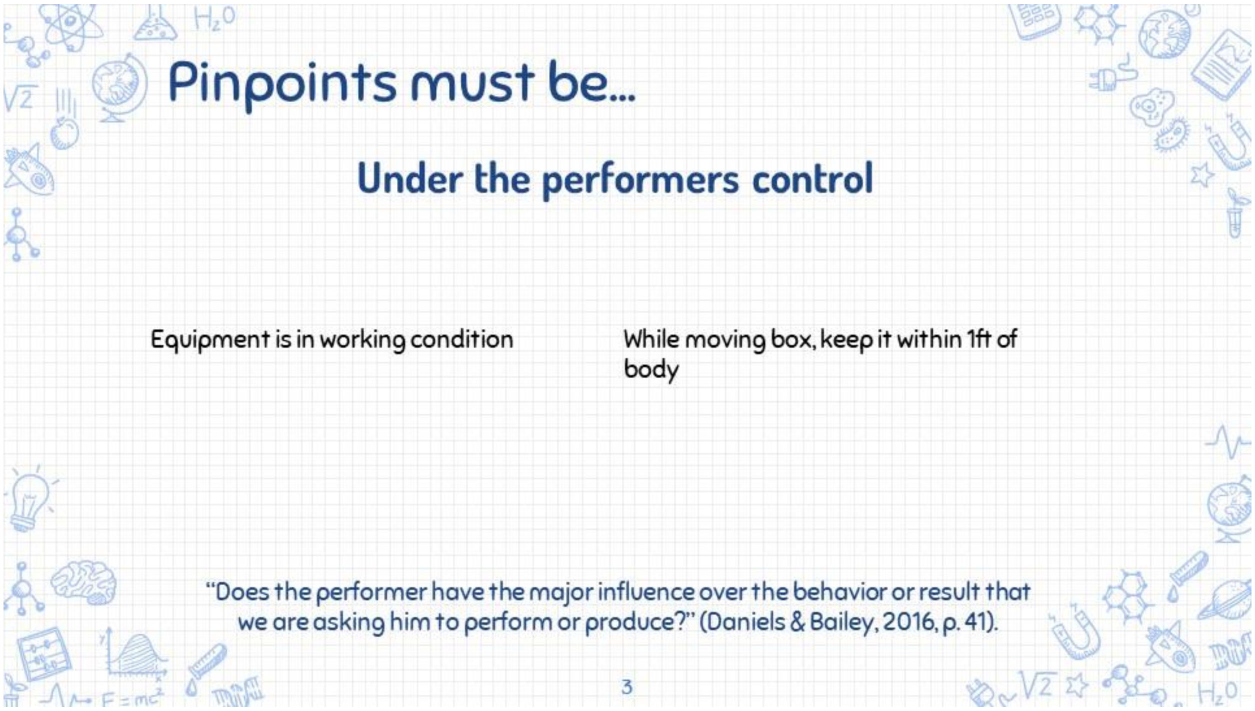

Checklist Format
(1) Make sure questions are detailed and worded positively.
Example 1: moved off platform after starting gear pump. VS Did not move off platform after starting gear pump.
Example 2: Put on leather cuff gloves VS. Was not wearing PPE
(3) Common barriers to safe actions. This allows for action items to come from the data while shifting the in field conversations to identifying barriers and having discussions to generate solutions.
(2) By using barriers instead of "unsafe" or "at-risk" you shift the discussion from blaming the employee to discussing barriers to their success.
Cutter Tasks
24 Began work after gear pump comes to complete stop Safe Barriers N/A
25 Prior to gear pump start up, put on face shield? Safe Barriers N/A
26 After changing filter or line start up, moved off platform beyond the buggy, immediately after gear pump start up? Safe Barriers N/A
Barriers affecting how work gets done
Lack of correct tool availability
Lack of PPE availability
Equipment limitations or flaws
Not enough people for job
It impedes my work
Time pressure
Unexpected equipment condition
Unclear/unsure of procedure / policy
Disagree with procedure / policy
Frustrated with work / task
Solutions for improving any of those barriers?

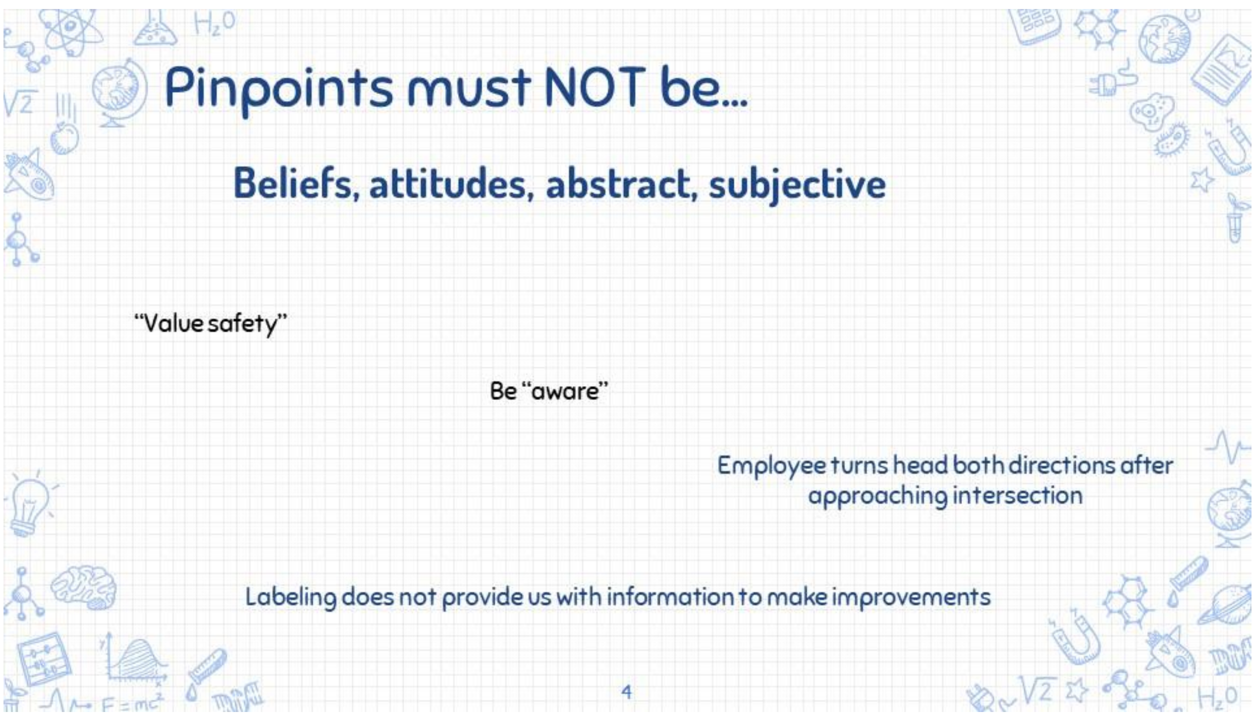
Appendix E

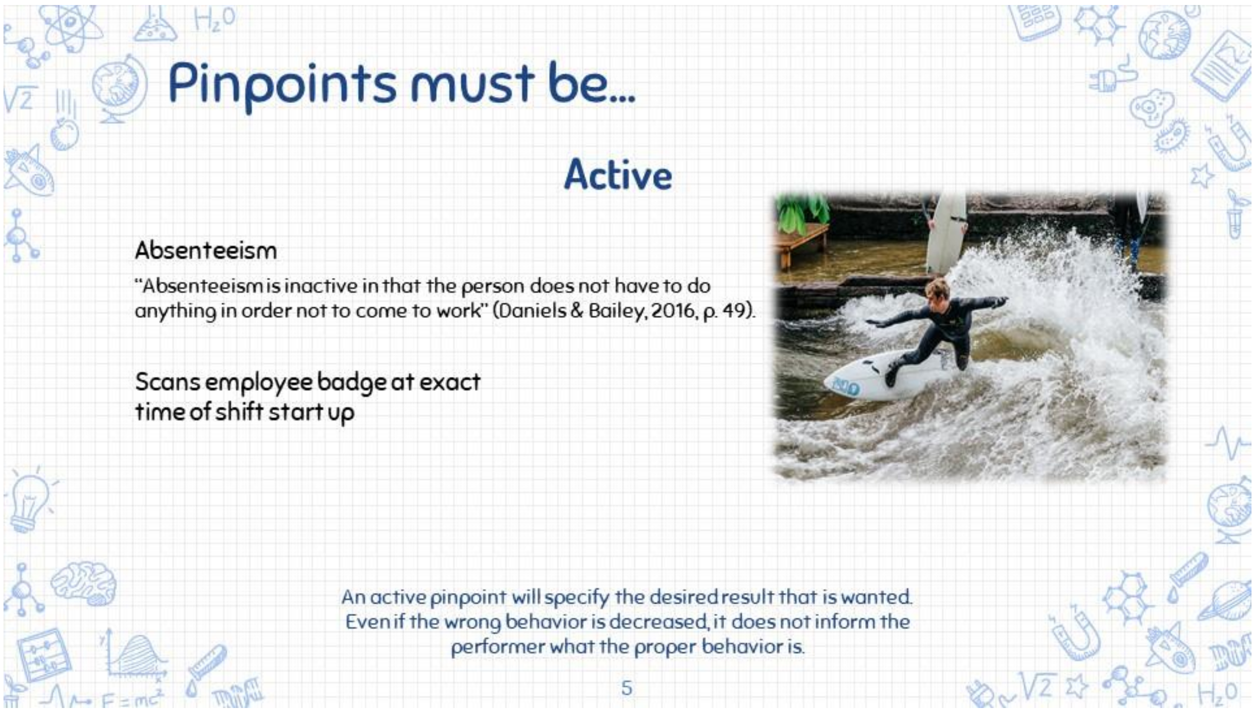
Pinpoint Criterion Training






Pinpoints must be...
Under the performers control
Equipment is in working condition
While moving box, keep it within 1ft of body
"Does the performer have the major influence over the behavior or result that we are asking him to perform or produce?" (Daniels & Bailey, 2016, p. 41).
3


Pinpoints must NOT be...
Beliefs, attitudes, abstract, subjective
"Value safety"
Be "aware"
Employee turns head both directions after approaching intersection
Labeling does not provide us with information to make improvements
4


Pinpoints must be…
Active
Absenteeism
"Absenteeism is inactive in that the person does not have to do anything in order not to come to work" (Daniels & Bailey, 2016, p. 49).
Scans employee badge at exact time of shift start up
An active pinpoint will specify the desired result that is wanted. Even if the wrong behavior is decreased, it does not inform the performer what the proper behavior is.
5


Pinpoints must be…
Active
Dead person test (Lindsley, 1991)
If a dead person can do it, it isn't behavior
6


Pinpoints must have...
Objects that behavior engages with
"Weld the rod to the equipment"
"Grab the box"
"place security seal"
"Delegate the task"
Describe behavior in terms of muscle movement. Physical interactions with the environment.
7


Pinpoints should specify...
When the behavior occurs
"Hold the handrail when walking down the stairs"
"While opening valve squat down with knees bent at 90 degrees"
8


Pinpoints should specify…
What the behavior achieves (or avoids)
"Hold the handrail when walking down the stairs **to avoid falling**"
"Put on gloves prior to touching equipment to **minimize potential for cuts**"
9


Practice!
10

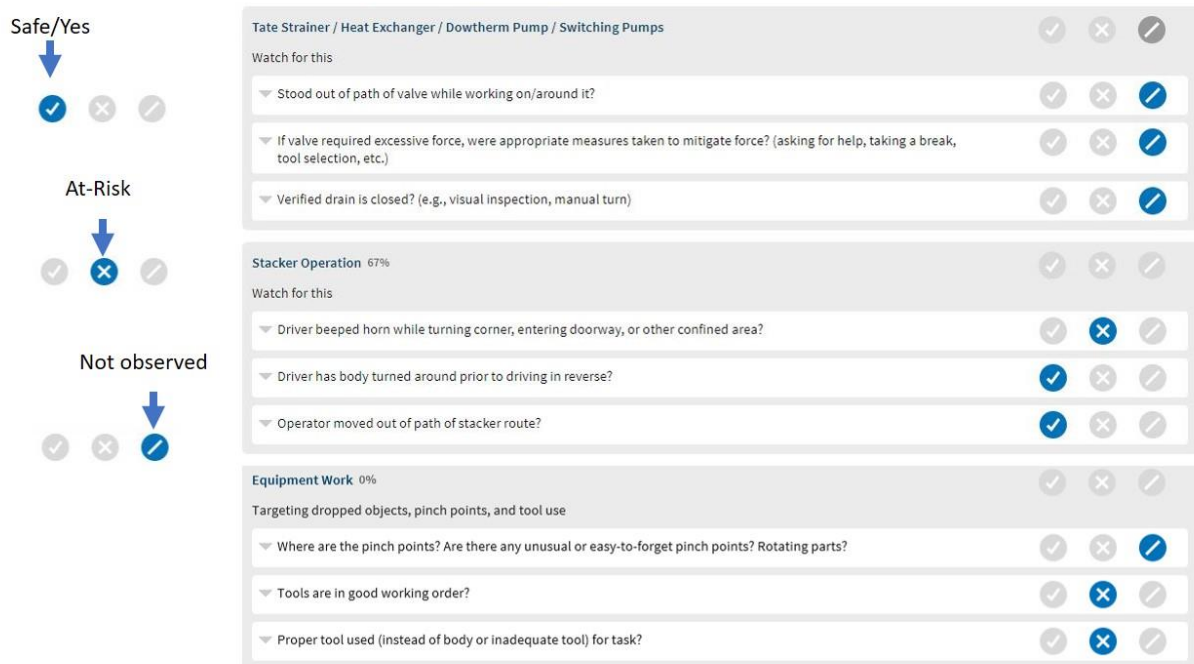
Appendix F

Example of Pinpointing Criterion Checklist

Question	**Tells you the bodily (or verbal) action that should happen? (Action)**	**Tells you the physical thing in the environment that the behavior is impacting?**	**Tells you when the behavior should occur?**	**Tells you what the behavior will achieve?**	**Observable & Measurable?**	**In the employees control?**	**Dead Person Test? (1 equals passed)**
#1							
#2							
#3							
#4							
#5							

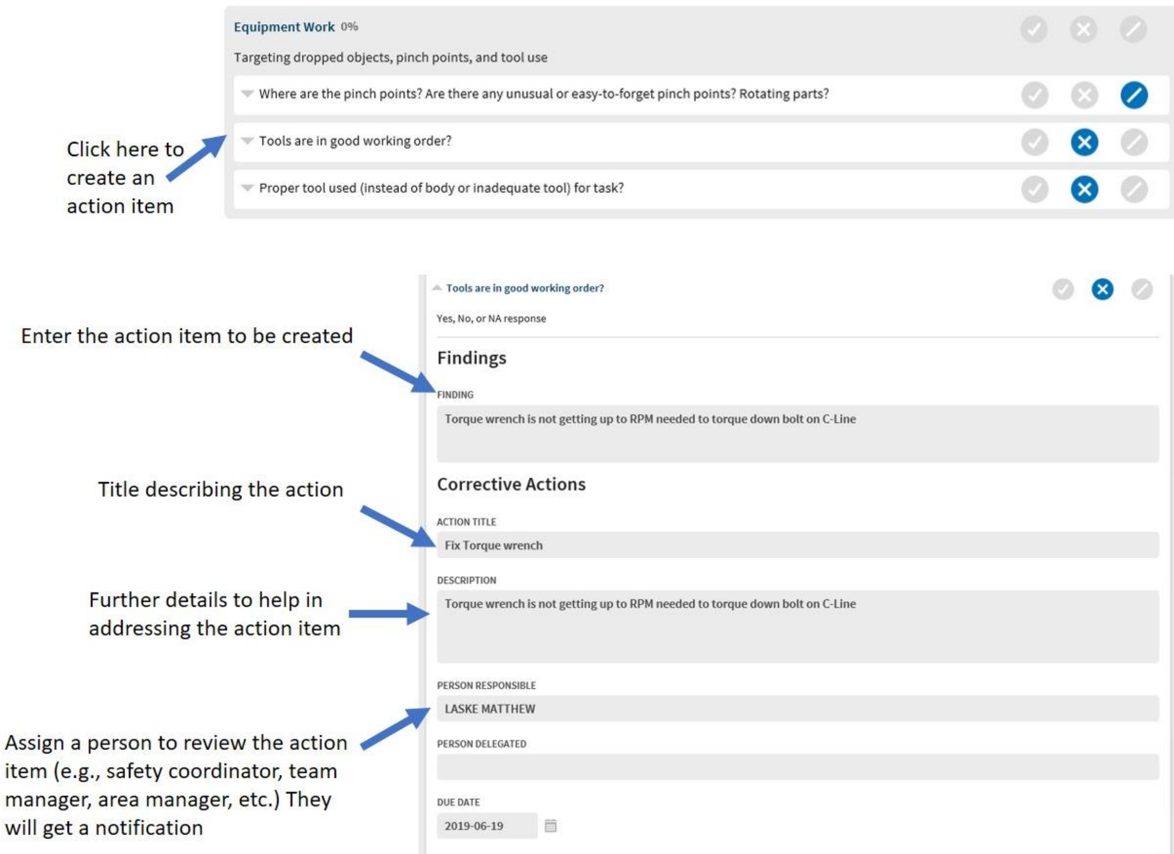
Appendix G

Example of Observation Checklist Computer Interface



Appendix H

Example of Action Item Creation from Behavioral Observation



Vita

Matthew Michael Laske was born in Kalamazoo, Michigan. He received his Bachelor of Science in Behavioral Science from Western Michigan University in 2018. In the fall of 2018, he accepted a research assistantship in Psychology at Appalachian State University and began study toward a Master of Arts degree in Industrial-Organizational Psychology and Human Resources Management. While at Appalachian State University, Matthew also pursued a graduate certificate in Business Analytics from the Walker College of Business. The M.A. and graduate certificate were awarded in August of 2020. He plans to begin study at the University of Kansas in the fall of 2020, where he will begin work toward his Ph.D. in Behavioral Psychology within the department of Applied Behavioral Sciences.