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Investigation of a "Sharps" Incident

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ABSTRACT

Special nuclear material research, process development, technology demonstration, and manufacturing capabilities are provided at the Los Alamos National Laboratory Plutonium Facility. Engineered barriers provide the most effective protection from radioactive and hazardous materials. The Worker Safety Security Team augments these passive safety feature by investigating incidents to identify appropriate prevention and mitigation measures. "Learning Teams" facilitate employee feedback loop and integration toward process improvement. This article reports an investigation of a "Sharps" incident and reviews a case study of a technician that cuts his left thumb while making a gasket. Causal analysis of the sharps incident uncovered contributing factors that created the environment in which the incident occurred. Latent organizational conditions that created error-likely situations or weakened defenses were identified and controlled. Effective improvements that reduce the probability or consequence of similar sharps incidents were implemented.

Introduction

At Los Alamos National Laboratory (LANL), there are several nuclear facilities, accelerator facilities, radiological facilities, explosives sites, moderate- and high-hazard non-nuclear facilities, a biosciences laboratory, and other facilities.[1] Special nuclear material research, process development, technology demonstration, and manufacturing capabilities are provided at the Los Alamos National Laboratory Plutonium Facility (TA-55). Engineered barriers provide the most effective protection from radioactive and hazardous materials.[2] These barriers have been incorporated through architectural and structural design and employ differential pressure zones, high-efficiency particulate air filtration, gloveboxes and radiation shielding in the design of the facility. The Worker Safety Security Team augments these passive safety features by investigating incidents to identify appropriate prevention and mitigation measures.

An incident is an abnormal condition, accident, or deviation from the planned outcome of a workplace activity that did or could have adversely affect health or safety of workers, the public, the environment, or the integrity of nuclear programs or facilities. A typical incident at TA-55 can result in worker exposure or contamination, waste generation, and work stoppage. Before work continues, the room is usually shut down until it is cleaned up and recertified for operations. “Learning Teams” facilitate the employee feedback loop and integration toward process improvement.

Tools intended for cutting or puncture, e.g., knives, scissors, ice picks, and drill bits, are routinely used in chemical activities. These tools may cause an open wound and are categorized as “Sharps”. The severity of the injury is compounded when the chemist is exposed to toxins, corrosives, irritants, radioactive materials, or sensitizers, because the

open wound is an injectable route of exposure. Injection is potentially the most serious mode of intake. Injection occurs in wounds that are a result of direct penetration by an object (i.e., a puncture or cut), of abrasion, or of burning by an acid, caustic, or thermal source.

In the following presentation, a sharps case study is reviewed. The contributing factors that caused the injury are analyzed. Underlying conditions, decisions, actions, and inactions that contributes to the incident are identified. These include weaknesses that may warrant improvements that tolerate error. Measures that reduce consequences or likelihood of recurrence are discussed.

Case Study: Thumb Wound from Cutting Gasket Material

The methodology described in a previous case study of a drum handling incident was again followed.[3] First, the incident was described. A "Fact Finding" meeting was conducted to establish a timeline. Causal factors were determined. Conclusions were drawn and corrective actions have been developed.

The Incident

On November 17, 2015, a research technician was making an O-ring using an "on-the-job O-ring splicing kit" that consisted of gasket material, a jig (to hold the gasket in place to perform a straight cut), a razor blade, and glue. As the technician cut the gasket (using his right hand) toward his body, the utility knife came in contact with and lacerated his left thumb that he was using to hold the plastic jig in place. See Figure 1.

Figure 1. Technician cuts thumb while cutting gasket material

The technician noticed blood, contacted his first line manager and was transported to Occupational Medicine. The laceration required three sutures for closure. The employee was released to return to work without restrictions on November 30, 2015.

The Critique

A “Fact Finding” meeting was held to discuss activities leading up to this incident. The incident timeline shown in Figure 2 was developed.

Technician Cuts Finger While Cutting Gasket Material

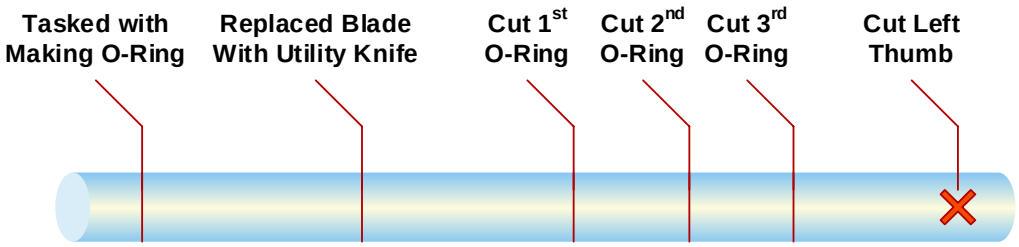

Figure 2. Sharps incident timeline

These key tasks occurred over a period of an hour. The worker substituted a utility knife for the razor blade to have a better handle to grip. The worker had made two cuts without incident prior to the injury. During the cutting motion the worker was applying pressure down onto the jig with the jig's seam separated enough for the blade to come into contact with the worker's thumb. The workers work control document did not require the use of cut resistant gloves or placement of items in a vice when using sharps. It was also noted that the hazards associated with cutting gasket material would be eliminated if gaskets were purchased from a manufacturer rather than being made on site.

Causal Factors

A cause-and-effect diagram was used to systematically review the causal factors that contributed to the incident. See Figure 3.

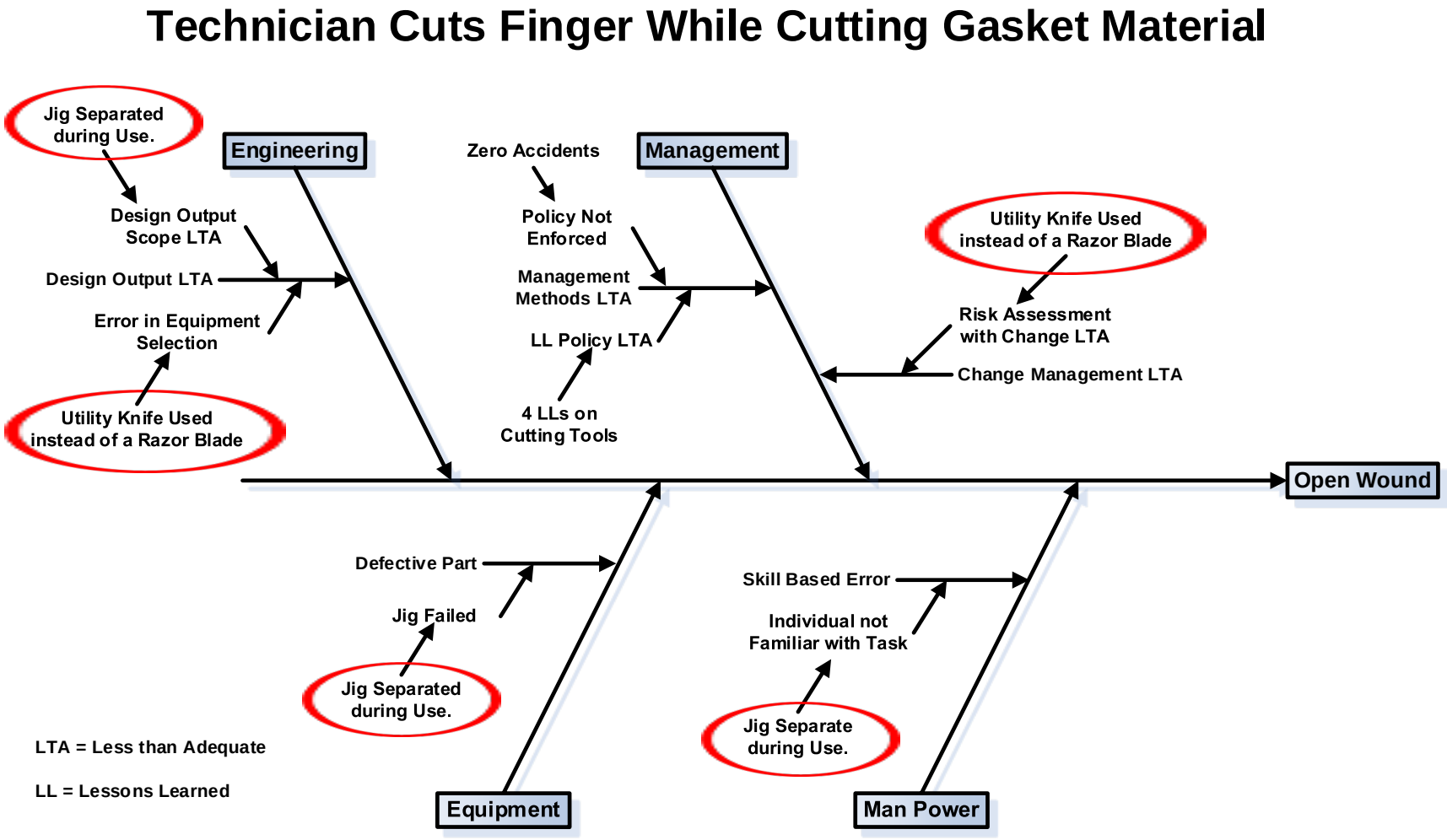

Figure 3. Cause-and-effect analysis of technician's cut wound

LTA is an acronym for “less than adequate.” LL is an acronym for “Lessons Learned.” Engineering, equipment, human performance (Man Power), and management errors have been compiled. The following factors contributed to the incident:

- The jig failed (separated due to lateral pressure).
- Utility knife was used instead of a razor blade.

In this case study, seven causal codes were identified. Casual factor definitions, explanations, context, and potential corrective actions are listed in Table 1. Recommended corrective actions from the Department of Energy causal analysis tree are highlighted.[4]

Table 1. Causal Analysis Tree Causal Codes

Casual Factor	Casual Factor Definition	Explanation	Context	Potential Corrective Action
A1B2C01	Design output scope LTA.	The jig was not designed to handle lateral pressure from a hand held tool during slicing task.	Jig was designed to be used with razor blade not a utility knife.	Replace part with one that designed for current environment.
A1B2C07	Error in equipment or material selection.	A utility knife was substituted for a razor blade/	A utility knife is a safer and easier to work with than a razor blade.	Replace part with one per applicable specifications.
A2B6C01	Defective or failed part.	The jig separate during use.	Lateral in addition to vertical slicing pressure occurred during the cutting task.	Replace the defective jig and return the system to normal operation.
A3B1C04	Infrequently performed steps were performed incorrectly.	Worker had performed this task only twice prior to injury.	Worker was not completely familiar with the tasks required based on not frequently performing the tasks and not operating at a fluency level.	Increase supervision or include additional personnel to peer check critical steps of the task.
A4B1C01	Management policy guidance / expectations not well-defined, understood or enforced.	Policy is not enforced.	Zero accidents policy require that cut resistant gloves be worn when working with sharps.	Modify safety and security policies to balance concerns and still meet operational mission.

Casual Factor	Casual Factor Definition	Explanation	Context	Potential Corrective Action
A4B1C06	Previous industry or in-house experience was not effectively used to prevent recurrence.	Similar incidents occurred at other DOE sites and at TA-55.	See 2014-LL-PNNL-0007, PNNL Staff Member Cuts Finger with Razor Blade, Y-2007-OR-BJCWM-0401, Hand Laceration, B-2006-OR-BJCETTP-0501, Subcontractor Employee Laceration, and LANL-ADPSM-2014-18, Good Catch! Cut-Resistant Gloves Prevent Hand Laceration.	Re-review the information provided particularly actions taken at other sites, determine if actions taken were effective and implement appropriate corrective actions.
A4B5C04	Risk / consequences assoiciated with change not adequately reviewed / assessed.	Elements of the process change were not recognized as having adverse impact or increased risk of adverse impact prior to implementing the change.	Since tool/jig was provided by the manufacturer as the tool to use to cut gasket material, the worker thought it was safe. Additionally, the worker had attempted to improve safety by using a hand-held utility knife versus the finger-held cutting blade provided by the manufacturer.	Review implementation of regulatory implications processing, examining the adequacy of the organizational structure in preparing for new regulations and responding to new regulatory challenges.

Conclusions

An apparent cause has been concluded from this causal analysis: a less than adequately designed jig combined with a substituted cutting tool that created excess lateral pressure caused the finger wound that required three stitches to close. Use of a vice or tool to hold the jig in place during cutting would have prevented the technician's thumb from being cut. Use of Personal Protective Equipment (PPE), i.e., cut resistant gloves, would have mitigated the thumb injury. Increased supervision or use of additional personnel to peer check critical steps of the task would have prevented the injury. Implementing Lessons Learned from four previous incidences could have prevented or mitigated the thumb injury. [5,6,7,8]

Corrective Actions

Based on the conclusions presented above, the following corrective actions have been recommended:

- Use a vice to hold the jig in place, thereby keeping fingers and thumbs away from the blade. See Figure 4.

Figure 4. Vice holding jig in place using utility knife to cut

- Use a straight blade with a handle when using a straight blade. See Figure 5.

Figure 5. Utility knife with auto retract function

- With worker involvement identify improvements to the work control document, i.e., require the use of cut resistant gloves and a vice or tool to hold jig in place during cutting and peer checking of critical steps of the task.
- Iterate the importance of the Lessons Learned Program.

Discussion

As shown in the case study, causal analysis provides additional insights in determining the causes of sharps incidents. The use of cause-and-effect diagrams in the analysis of glove breaches and failures and air-purifying respirator, drum handling, and metal-halide lamp fire incidents, have been previously reported in this journal.[9] In this incident, replacement of a razor blade with a utility knife was the active error that triggered the immediate, undesired consequence: a cut to the thumb requiring three

stiches, as shown in Figure 1. In the causal analysis, engineering, equipment, human performance, and management issues were uncovered.

Since the jig was provided by the manufacturer as the tool to use to cut gasket material, the worker thought it was safe. In an attempt to improve safety, the worker replaced the finger-held cutting blade provided by the manufacturer with a hand-held utility knife. Note that substitution of the utility knife for a razor blade would **not** have triggered a Management of Change Review. Making this change in the procedure would improve performance and safety in three ways:

- A hand-held utility knife cuts the O-ring more efficiently than a finger-held cutting blade.
- A hand-held utility knife is a safer cutting tool than a finger-held cutting blade.
- From an ergonomic prospective, less repetitive strain injury due to repetitive tasks and forceful exertions would occur.[10]

It is important to note that this incident demonstrated how even though the worker was using the correct tool kit for the job, there was room for improving the selection of tools and worker technique. As a safety precaution the worker evaluated the hazards associated with handling a straight blade and chose to use a utility knife. The worker should be commended for improving the hazard control system for this task.

The cause-and-effect diagram identified two apparent causes: replacement of the finger-held cutting blade with a hand-held utility knife and the failed jig, as shown in Figure 5. Coupled together, these two apparent causes are the apparent root cause. The seven causal codes identified organizational weaknesses in skill-based tasks and management methods, as shown in Table 1.

Redesigning the jig, such that the seam will not split from the added lateral pressure from using a hand-held utility knife instead of a finger-held cutting blade would prevent recurrences. With the advent of 3D printing,[11] (various processes used to synthesize a three-dimensional object) this should be a simple design change. Increased supervision during changes to the task and peer checking would reduce the skill-based errors.[12]

When TA-55 management policy guidance or expectations are not enforced, safety policies are modified to balance concerns and still meet the TA-55 operational mission. If TA-55 management direction creates inadequate awareness of the impact of actions on safety, appropriate safeguards must be reexamined. TA-55 management expectation must be integrated into organizational programs (such as the Worker Safety Security Team), and system designs, so that employees are trained and skilled in the understanding of operational limitations and safety parameters.

The previous papers in this series published in this journal discussed the value of a Lessons Learned Program.[3,9] As the causal node, A4B1C06, in Table 1 demonstrates, the Lessons Learned Program used was not effective. Four incidents of fingers and thumbs getting cut with sharps were documented during the last ten years.[5–8] The corrective actions listed above, especially the use of a vice and cut resistant gloves, would have prevented or mitigated the hand injury.

Using an approach similar to that presented in the "Light fixture fire" paper,[9] the fact finders identified the following steps that can be taken to ensure implementation of Lessons Learned related to fingers and thumbs getting cut with sharps:

1. Assign a sharps subject matter expert (SME).
2. Have the SME make an inventory of sharps.
3. Have managers perform an inspection of sharps in their areas of responsibility.
4. Have the SME revise procedures with the use of sharps to incorporate the following corrective actions:
    - Use a vice to hold the jig in place keeping fingers and thumbs away from the blade.
    - Require the use of cut resistant gloves.
5. Have line managers review procedures with the use of sharps to ensure that the corrective actions have been incorporated in the procedure.

Although human (active) error typically triggers an injury or illness, latent errors, the true causes, will not be discovered and errors and incidents will persist.[13] Latent errors are those that result in an organization-related weaknesses or equipment flaw that lie dormant until reveled either by human error, testing, or self-assessment. Unlike active errors which result in an immediate injury or illness, latent errors may go unnoticed because they have no immediate outcome.

The hierarchy of effectiveness for hazard controls is the following: elimination, substitution, engineering controls, administrative controls, and last, PPE. Purchasing gaskets from the manufacturer is an example of elimination. Using a vice is an example of an engineering control. Wearing cut-resistant gloves is an example of PPE use.

The main objective of reviewing incidents is to maintain the risk associated with TA-55 operations at an acceptable level. From a business viewpoint, the acceptable level

may be achieved when the costs of further decreasing a given risk are greater than the costs realized from work-related injuries and illnesses. Because the magnitude of a risk involves both the likelihood and the severity of the associated harm, the performance of incident reviews can be reasonably based on reducing either the severity or the likelihood of TA-55 work-related injuries and illnesses. Implementing the corrective actions discussed above would have decreased both the severity and the likelihood of TA-55 sharps related injuries.

When a measure is proposed to improve the hazard control system of TA-55 operations, risk factors that cause injuries and illnesses must be considered and evaluated. There were weaknesses in the process: extra lateral pressure (from switching from a finger-held cutting blade to the hand-held utility knife) and the jig being able to separate during use were not foreseen. Nevertheless, collecting incident review data gives TA-55 management information they need to concentrate on vulnerabilities that require TA-55 management support. The results presented in this paper are pivotal to the ultimate focus of reviewing incidents, which is to minimize work-related injuries and illnesses.

In summary, substituting a hand held utility knife for a finger-held blade created enough lateral pressure to cause the jig seam to separate. The utility knife cut the worker's thumb and three stitches were needed to close the wound. Corrective actions included using a vice or tool to hold jig in place and wearing cut resistant gloves during the cutting task. A significant improvement to the task consists of eliminating the task of cutting O-rings altogether and purchasing gaskets directly from a manufacturer.

Conclusions

Causal analyses of sharps incidents uncovered contributing factors that created the environment in which the incident occurred. Latent organizational conditions that create error-likely situations and weaken defenses have been identified and controlled. Incorporating corrective actions selected from the DOE causal analysis tree provided corrective actions based on decades of incidences. Effective improvements that reduce the probability or consequence of similar sharp incidents have been implemented.

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