Methods For Preventing Accidental Exposure From Hazardous Energy
And Moving Equipment

By

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ABSRACT

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METHODS FOR PREVENTING ACCIDENTAL EXPOSURE FROM HAZARDOUS ENERGY AND MOVING EQUIPMENT

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This paper will present the issue of employee injuries and deaths from accidental exposure to hazardous energy and moving equipment. The paper will investigate the reasons why employees may perform unsafe acts, resulting in accidents and loss. Data and information will be obtained from the XYZ Company, and their experience with losses associated from employee contact with hazardous energy and moving machinery.

A literature review will discuss several cases of workplace injuries and fatalities that occurred from contact with moving equipment and uncontrolled energy. The sources of hazardous energy will be identified, along with scenarios and case histories outlining circumstances when the serious accidents occurred. The paper will progress to present a series of preventive strategies for achieving worker compliance with safe practices and safe procedures, designed to minimize industrial accidents and the subsequent human and operational losses.

The efficacy of OSHA and other regulatory involvement in efforts toward setting and meeting compliance standards will also be explored. Several of the instruments presented in the paper will be analyzed and evaluated for their effectiveness in preventing employee accidents and in reducing the XYZ Company's overall risk. The preventive techniques measures will be tested and compared with the XYZ Company's accident history, prior to the implementation of the corrective measures.

The paper will conclude with recommendations provided for the XYZ Company to direct management and employee involvement in energy control and machine guarding. The objective will be to build and maintain a safe working environment along with fostering continuous improvements in safety and risk control.

Data received from surveys and instruments utilized in the XYZ study can then be extrapolated and applied to other companies seeking to reduce accidents involving accidental exposure to moving and energized equipment. The goal will be to present sound, practical and proactive programs and tactics that can lead to safe work practices and working conditions. This will help improve the operational and financial effectiveness of organizations and their employees. The results will also work toward reaching regulatory compliance and teach employees to safely work with and around energized and moving equipment.

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CHAPTER ONE

Statement of the Problem

Introduction

Why do employees continue to risk becoming seriously injured or killed while working in and around moving machinery? What methods can employers take to ensure the safety of their employees who work around moving or energized equipment? What is necessary for a company to operate profitably, while following established workplace safety rules and regulations? This study will examine accidents analyzing data obtained from The XYZ Company, a firm that has experienced serious industrial accidents – and where the possibility of a re-occurrence continues to exist.

The XYZ Company employs 500 workers at its rural center in the Midwestern United States. The factory produces consumer brands that are distributed nationwide. The Company experienced major human and business losses in 1994 and 1995, resulting from employee contact with moving or energized equipment (Figure 1).

Figure 1: Serious Injuries Involving Employee Contact with Moving Equipment

Date	Accident	Direct Workers' Compensation Costs
1994	Hand crushed between moving parts	$225,000
1995	Hand caught when machine started-up	75,000

Between 2001 and 2002, another series of accidents occurred, with circumstances similar to the 1994 and 1995 events. Though less serious, the more recent accidents have raised the threat of a future catastrophic accident (Figure 2), unless adequate controls can be applied.

The employees represented in Figure 1 were injured while attempting to clean equipment or remove jammed materials. Following these serious accidents, operating procedures, equipment design, and safety training focused on trying to prevent such an event from happening again. The injuries described in both Figure 1 and Figure 2 occurred when equipment unexpectedly started up, or when employees reached around guarded machinery.

Figure 2: Recent Injuries Resulting from Contact with Moving Equipment

Date	Accident	Direct Workers' Compensation Costs
February 2001	Hand scraped when machine started-up	$750
February 2001	Finger lacerated by moving bar	250
July 2001	Burned fingers when machine clamped	450
January 2002	Bruised arm when machine started-up	850
April 2002	Finger laceration from moving part	200

During the period from 1994 to 1995, the responsibility for safety and health at the XYZ Company was shared across the management team. There was no single position dedicated toward monitoring employee safety and health. Following the two accidents described in Figure 1, a full-time safety resource person was hired. The XYZ Company, like other employers, is required to follow guidelines defined by the Occupational Safety and Health Administration (OSHA). The standards identify safety rules and regulations that require employers to recognize hazards and provide a safe working environment.

The primary OSHA standards associated with the losses reported in Figures 1 and 2 are the Control of Hazardous Energy (CFR 1910.147), and Machine Guarding (CFR 1910.211 – 222). CFR 1910.147 is also referred to as 'lock-out/tag-out'. The lockout-tag-out standard was enacted by OSHA in 1989. Guidelines and rules for

working around moving equipment were in place prior to the OSHA regulations (Lock-out procedures, safe practices bulletin, 1974). OSHA requirements for the control of hazardous energy compliance are straightforward, yet violations of the standard continue to occur (Preuss, 2001). From October 1998 to September 1999, OSHA delivered 3,195 citations in violation of lock-out/tag-out, with penalties totaling more than $4,269,000 (Preuss, 2001). Of the top ten mistakes companies make in violating the lock-out/tag-out standard (Business & Legal Reports, 2000), five contributed to the accidents reported in this study:

1. Failing to lockout equipment located nearby.
2. Failing to recognize all energy sources.
3. Not completely isolating or dissipating energy sources.
4. Failing to update procedures for new or changed equipment.
5. Non-maintenance workers not trained on lock-out/tag-out procedures.

Inadequacies in training, along with the lack of effective machine guard safe practices were determined as basic causes for the injuries reported by the XYZ Company. Two significant factors were identified for analyzing the risk of accidental exposure when working with machine guarding during all operational phases: the severity of foreseeable injuries that could occur; and the probability of their occurrence (Snopek, 1998). Applying a probability matrix would consider three aspects in preventing accidents from exposure to unguarded parts: 1) Probability of the injury; 2) Severity of the injury; 3) Frequency of exposure (Snopek, 1998). An analysis for preventing injuries applying regulatory guidelines and safe procedures relating to machine guarding and lock-out/tag-out will be outlined in this study.

Research has shown that injuries resulting from contact with moving machinery are likely to occur when employees attempt to remove jammed or broken parts from the equipment. “The most hazardous situation is when the operator is adjusting the

machine or removing jammed work or broken parts. This is the time when most injuries occur" (Business and Legal Reports, 1999b).

The basic causes determined from the accident investigations at the XYZ Company revealed three common trends:

1. Employees did not demonstrate understanding of the risks associated with working around moving equipment or machinery that could unexpectedly start-up.

2. Neither operating equipment nor established policies were regularly audited.

3. Employees did not receive timely, adequate feedback regarding expectations for following safe practices and procedures.

What are the consequences of these risks? "Employees servicing or maintaining machines or equipment may be exposed to serious physical harm or death if hazardous energy is not properly controlled" (OSHA fact sheet on lock-out/tag-out, 2002). In an informational fact sheet on amputations, OSHA reported that industrial injuries could occur when workers operated unguarded or inadequately safeguarded mechanical equipment (OSHA fact sheet on amputations, 2002). Activities involving stationary machines also expose workers to potential amputations or other serious injuries. These activities include cleaning machines and clearing jams.

It was in performing these functions that the injuries in 1994 and 1995 resulted. The incidents that occurred in 2001 – 2002 also involved cleaning equipment and clearing jams. In performing these functions, workers were exposed to moving parts. The three mechanical components that are hazardous and can lead to injuries are:

1. The point of operation –area of a machine where work is performed.

2. The power-transmission– machine components that transmit energy.

3. Other moving parts – machine components that move during operation (OSHA fact sheet on amputations, 2002).

Machine guards are required at the point of operation, places where moving parts contact or come close together, pinch points, rotating parts, and blades or cutting locations. Machine parts that move to cut or form materials can also cause severe injuries as well (Business and Legal Reports, 1999a). Employers should be able to recognize, identify, manage and control machine hazards caused by mechanical components, the motion that occurs in or near these components, and the tasks that workers perform during operation (OSHA fact sheet on amputations, 2002).

Recommendations for preventing injuries include safe work practices, employee training, and administrative controls. Specific recommendations and strategies will be provided for the XYZ Company in Chapter Five. Affixing machine safeguarding along with implementing safe work practices and procedures for the control of hazardous machinery are effective methods for preventing severe injuries caused by stationary or moving machinery (OSHA fact sheet on amputations, 2002).

Statement of the Problem

This study will evaluate the risk of XYZ Company employees coming in contact with moving machinery. Accidental exposure and contact with operating equipment could result from unsafe conditions or practices associated with violations of the OSHA lock-out/tag-out and machine guarding standards. The losses may appear as injuries, increased workers' compensation costs, regulatory (OSHA) citations, and lost production.

Purpose of this Study

The purpose of this study is to design and implement risk control strategies for the XYZ Company, with the objective of preventing injuries and losses associated from employee contact with moving equipment. The measures will be directed by management and include participation by employees. The target date for initiating the strategies is effective upon review and approval by XYZ Company management.

Objectives of the Study

There are three main objectives of this study. They are:

1. To assess the current level of risk of accidents and injuries occurring to XYZ Company employees.

2. To identify best practices for companies and their employees operating or working around industrial equipment. This will include reports of how organizations with similar circumstances to the XYZ Company have responded and improved working conditions for their employees.

3. To determine controls and processes to prevent further losses or exposure.

Background and Significance

Injuries described in the problem statement, along with previous XYZ Company losses, underscore the necessity of pursuing this issue. From October 1, 2000 to September 30, 2001, OSHA proposed 7,336 citations for alleged violations of the lock-out/tag-out standard. There were an additional 4,994 citations proposed for alleged violations of machinery and machine guarding regulations. Lock-out/tag-out violations were the fourth highest category of proposed citations, and machine guarding represented the sixth highest regulations violated (OSHA *most frequently cited standards, 2001*).

Comment:

The average cost of a workplace disabling injury ($28,000) and death ($910,000) (Accident facts, occupational injuries and illnesses, 1999), present excessive workers' compensation expenses and can adversely affect the employer on both a personal and organizational level (Bean & Lawrence, 1999). Apart from regulatory compliance (OSHA regulations are minimum standards), contact with moving equipment can result in devastating, life-altering changes. Employee injuries can produce significant direct expenses (such as medical bills and indemnity). The impact of indirect costs (such as business interruption, operational downtime and negative public image) can increase

overall losses by 4.5 times the direct charges (Safety Pays, 1986). Above and beyond the workers' compensation arena are possible civil and criminal action that can be taken against supervisors and management if willful or egregious knowledge of hazards is proven.

Definitions

Contact with energized equipment is assumed to be an employee being struck by or caught in a piece of moving or energized equipment. The equipment could be in the process of performing its work cycle, could accidentally start-up through employee actions (such as pressing a start button), or the release of stored energy (such as opening a steam valve). Machine guards are devices or shields that protect employees from accidental contact with moving parts. These guards may be attached through a variety of means, such as fixed (bolted), or interlocked (controlled by a sensing switch that stops the machine if the guard is opened or removed).

Limitations

The scope of this study is on analyzing accidents and providing recommendations based on injury reports and subsequent data collected and received from the XYZ Company. While comparative evaluations may be applied to other organizations, the recommendations in this study will apply to the ability of the XYZ Company to reduce the risk of injuries occurring at its facility due to lock-out/tag-out or machine guarding violations. Therefore, the results may be limited in their ability to be generalized to other companies.

Definition of Terms

Code of Federal Regulations (CFR) – These are a series of federal statutes and standards governing a wide spectrum of requirements for employers in the United States.

Direct Workers' Compensation Costs - The actual medical expenses and wages paid directly to employees who experience work-related injuries and illnesses.

Energized equipment. - Machinery that is supplied by a form of energy (such as electricity and steam).

Indemnity - Payment made to employees under the workers' compensation system, resulting from workplace injuries or illnesses. These payments represent a portion of the employee's normal wages, to compensate for their temporary and/or permanent inability to return to work.

Lock-out/tag-out - The ability to control stored and active energy (such as electrical, steam, air) on a particular piece of equipment by locking or physically stopping the machine from activating.

Machine guard - A fixed or applied barrier or device that prevents accidental contact with moving equipment.

The Occupational Safety and Health Administration (OSHA) - The federal or state agency assigned to monitor and enforce workplace safety.

OSHA Recordable Rate – this is the number of reported occupational injuries and illnesses that meet a defined criteria established by OSHA. The employer records its job-related injuries and illnesses on a log and summarizes the information annually to OSHA. A rate is then calculated based on the number of reported injuries and illnesses multiplied by 200,000, then divided by the total number of employee hours worked over the same period. That score is tabulated and used by the agency to compare companies within the same standard industrial classification (SIC) code.

CHAPTER TWO

Review of Literature

Introduction

The enactment of the lock-out/tag-out standard was projected to prevent hundreds of accidental deaths and injuries from the accidental start-up of hazardous energy. Even with federal and state regulations, injuries and deaths from contact with moving or unguarded machinery and their parts have continued. This chapter will review relevant literature and sources to examine if there is a relationship between employee behavior and the occurrence of occupational injuries associated from contact with moving machinery.

Recommendations and models designed to reduce the possibility of employee contact with moving machinery will be presented in Chapter Three. To better illustrate the magnitude of the potential for injury, Figure 3 defines the forms of energy present in the workplace:

Figure 3: Definitions of Common Workplace Energy Systems

Potential: Stored energy that can be drawn upon to do work.

Kinetic: Energy resulting from moving objects.

Flammable: Energy converted from combustion.

Chemical: The capacity of a substance to do work or produce heat.

Electrical: Energy generated through the conversion of other energy forms.

Heat: Energy transferred from one body to another as the result of a difference in temperature, such as steam.

Radiation: A flow of atomic – subatomic particles and waves such as X-rays and lasers. (Lockout & tagout. Oregon OSHA's guide to controlling hazardous energy, 2002.)

Important considerations in relation to hazardous energy include knowing what will happen if the energy is released, and how to control the resulting energy. Application of the lock-out/tag-out standard would apply to situations involving the removal or bypassing of safety guards or interlocks, or placing any part of a person's body into an operating area or danger zone associated with the machine. Service or maintenance work that is part of normal production operations would not be covered under the OSHA regulations (Lockout & tagout, 2002).

Accidents and Their Effects

Several case histories are reported to describe the tragedy of employees injured or killed while on the job when exposed to moving machinery:

A recycling packer died after becoming crushed inside of a paper-recycling bin. A mechanical ram exerting 118 tons of force was accidentally triggered by the employee while he was inside of the bin. Although there were no witnesses to the accident, it is hypothesized that the victim entered the bin to try to manually dislodge or retrieve obstacles inside. The investigator concluded that deficiencies and contributory factors to the accident included the employer's lack of following effective lock-out/tag-out procedures, and that the main power source for the recycling bin was located in an area difficult to access (California Fatality Assessment and Control Evaluation (FACE), 1995).

An excavation/load machine operator was inspecting a lifting device when a co-worker pressed a switch that activated the machine's hydraulic arm. The mechanical arm crushed the operator against the side of the machine (Lockout & tagout, 2002).

A machine operator raised a dumpster to do clean-up work beneath it. He raised the dumpster by jamming a bar into a hydraulic cylinder control button so that it would stay in the 'up' position. The cylinder failed and the dumpster fell, crushing the worker (Lockout & tagout, 2002).

An employee was killed while attempting to couple a hose on a high-pressure liquid cutter. When the liquid cutting unit failed, the employee was injected in the abdomen with a water stream (Lupton, 2001).

An employee was crushed when a scissors lift powered by hydraulic energy descended onto him. One of the findings from the resulting inspection indicated a lack of training in lock-out/tag-out (Sanchez, 2002).

A part-time worker in a department store was killed after raising the loading gate of a baler during its upstroke. The worker apparently placed his head and upper body into the space above the compacting head, or platen of the ram. When the ram activated, the worker's neck was caught between the raised loading gate and upper surface of the platen (Informational Alert #9, 1991).

OSHA Citations

OSHA conducts investigations following serious occupational accidents and deaths. Many of the inspections result in significant penalties and citations against the employer for violations against established regulations and standards. The regulations pertaining to lock-out/tag-out and machine guarding are clearly defined. The proposed citations often relate to a lack of written programs and employee training for following energy control and protection against contact with moving parts. In the case of the employee killed by a high-pressure water stream, OSHA levied a proposed fine of $63,000 for willful and serious safety violations (Lupton, 2001).

A willful violation is one committed with an intentional disregard of, or plain indifference, to the requirements of the Occupational Safety and Health Act and its regulations. A serious violation is one in which there is substantial probability that death or serious physical harm could result, and the employer knew or should have known of the hazard (Lupton, 2001).

The alleged serious citations in the above case proposed included failure to provide a workplace free from recognized hazards (Lupton, 2001). In the case of the employee killed by the descending scissors lift, OSHA proposed penalties of $102,000. The serious penalties included a lack of enforcing lock-out/tag-out procedures, failure to conduct periodic inspections of energy control procedures, and unguarded pinch points (Sanchez, 2002).

There are other examples pertaining to lack of effective machine guarding safety procedures. Following an accident resulting in an amputated arm, OSHA proposed penalties of $62,450, for 27 alleged serious violations, including failure to provide adequate machine guarding (Williams, 2001). A textile manufacturer received proposed fines of $74,625 after an operator sustained crushed fingers when his hand was pulled into an inadequately guarded machine (Fitzgerald, 2002).

Accident Prevention and Loss Reduction

Accident prevention is a critical element for avoiding human suffering and regulatory penalties for companies that require employees to work around energized machinery. One control method is to follow established OSHA regulatory compliance standards.

OSHA or Other Regulatory Compliance Standards

The two primary areas of regulations described in this report are lock-out/tag-out and machine guarding. As defined by OSHA, the first step of compliance with lock-out/tag-out is to begin an energy control program. The agency sets minimum standards. It is up to each employer to tailor or customize the standards to fit their company's needs. The energy control program must have three components:

1. Written energy-control procedures. These procedures clearly identify the sources of energy and describe how workers will secure energy-isolating devices, use and remove locks and tags, and test the effectiveness of energy-isolating devices.

Procedures are to be conducted in the following sequence:

a. Prepare to shut down the equipment.

b. Shut down the equipment.

c. Isolate the equipment from the energy source.

d. Lock-out or tag-out the energy isolating device.

e. Eliminate potentially hazardous stored energy.

f. Verify that the equipment is isolated from hazardous energy.

g. Re-energize equipment after completing service or maintenance work.

h. Remove the lock-out or tag-out device. (Lockout & tagout, 2002)

2. Effective training prepares workers authorized to perform the actual service or maintenance work. These workers must learn how to find and recognize hazardous energy sources, understand the types and magnitudes of energy in the workplace, and be able to locate the primary energy source locations (Lockout & tagout, 2002). Authorized employees should complete a practical, hands-on certification on each piece of equipment that they are expected to operate. Affected employees work around machines or equipment. They should be provided with a basic understanding of machine guarding and lock-out/tag-out. These employees need to understand the purpose of the company's energy control procedures, know how the procedures are applied, and how the procedures can protect them (Lockout & tagout, 2002).

3. Periodic inspections include a regular review and evaluation of written procedures, as well as monitoring employees for the correct application of lock-out/tag-out practices. Following are the required elements for a lock-out/tag-out inspection:

a. Which equipment is inspected

b. The inspection date

c. The workers included in the inspection

d. The person performing the inspection

The inspection should confirm that employees: follow the energy-control process; understand their responsibilities; perform the required lock-out/tag-out procedures; and have opportunities to provide feedback for strengthening or improving the program. Determinations from the inspection should include the following elements:

a. Whether workers are following energy-control procedures

b. If workers involved in the inspection are aware of their responsibilities

c. If the procedures adequately protect employees

d. The necessary changes to improve the safety of the authorized and affected workers.

Voluntary Compliance

It is important to remember that OSHA standards are the minimum requirements companies must follow. Employers are expected to take additional measures to protect their workers by promoting a safe working environment beyond the established regulations. When these measures are followed, the possibility of a serious or fatal accident can be significantly reduced. In many cases, the recommendations are global and generalized.

For the program to be effective, individualized training and procedures need to be applied. For most employers, OSHA offers a variety of services to assist with compliance. One is called the Voluntary Protection Program, or VPP. Under the VPP, employers apply for the program through a series of steps. Part of the process involves a site inspection by a team of OSHA officials. Hazards found during the site visit are identified for the employer to address. Other aspects of the VPP include conducting safety audits and providing employee training toward meeting the required standards. Once VPP status is achieved, the employer becomes exempt from programmed inspections, although the company may still receive an OSHA inspection triggered by

another reason, such as employee complaint or serious accident (Recognizing excellence in safety and health, OSHA VPP, 2002).

Another program available is forming a partnership between the employer and OSHA. This is usually organized for employers with multiple locations. The partnership addresses focused areas, such as improving safety and recognizing hazards in a particular industry. A third service OSHA offers is provided through its consultation division. Agency consultants work with employers to identify and correct unsafe conditions and practices. Many small employers take advantage of this service to help correct identified hazards and prevent accidents (How to propose a partnership, 2002).

Recommendations

Several recommendations were analyzed for reducing accidents associated with energy or moving equipment. In some cases, the recommendations were specific to a particular accident investigation. For example, in the case of the recycling packer described previously, the following recommendations were made:

1. Develop and implement a lock-out/tag-out procedure for all employees who operate or maintain any type of industrial machinery.
2. Assure that compactors are guarded to prevent workers form coming into contact with the operating ram and prevent workers from entering the travel zone of the ram.
3. Develop a comprehensive written Injury and Illness Prevention Program.
4. Conduct periodic surveys to assess and correct safety hazards.
5. Train employees in safe emergency rescue procedures (FACE, 1995).

In the case of the accident described where an operator received a crush injury against the side of the machine, recommendations were: “The operator should have turned the machine off, removed the key and put it in his pocket, and secured the hydraulic arm against gravity” (Lockout/tagout, 2002). In response to the incident where

an employee was crushed by a dumpster, the recommendations stated: "The operator should have blocked the dumpster so that it would not fall if the hydraulic cylinder failed" (Lockout & tagout).

General accident prevention measures can be prepared and directed toward preventing accidents facility-wide. The XYZ Company implemented a comprehensive behavioral-based safety process that will be explained further in Chapter Three. Core values have been established to guide employees in the accident prevention process. The company's core values are:

1. Nothing you do is worth getting hurt over.
2. Safety is everyone's responsibility.
3. Every accident should have been prevented.
4. Safety and health can be managed (Key Concepts of Safety, 1996)

To further elaborate on the 4th core value, the XYZ Company has set-up supporting guidelines: 'Educate, set expectations, and then hold accountable' (Key Concepts of Safety, 1996). Guidelines for preventing accidents resulting from contact with energy and moving equipment can also be collected across a range of conditions and practices. One such list is described in a report presented below:

1. Identify all jobs and equipment that require lockout of power sources.
2. Post warning sings wherever possible to indicate that lockout is required.
3. Develop written procedures explaining how lockout is to be done.
4. Train all personnel in the lockout procedures for their particular job.
5. Offer periodic refresher training.
6. Allow no deviation from the written policies and procedures (accountability).
7. Use engineering and administrative controls as much as possible to eliminate the need for lockout.
8. Perform regular maintenance to prevent malfunctioning equipment.

(State Compensation Insurance Fund, 2002).

Other recommendations may be specific to the situation or equipment that is available. The recommendations may be organized into the following categories:

1. Engineering controls
2. Training, certifications and communications
3. Audits, inspections and checklists
4. Policies and procedures
5. Written programs
6. Equipment and criteria for lock-out/tag-out devices

(State Compensation Insurance Fund, 2002).

An explanation and examples of these general recommendations follows:

Engineering Controls

Engineering controls include placing machine guards over exposed parts, and preventing employees from coming in contact with moving machinery. One example is an interlocked door. Switches can be bypassed or defeated (such as with a magnet), so other controls such as lockout/tagout devices, safe procedures and practices need to be applied.

Training, Certification and Communications

Employee training and measuring learned performance is critical for protection against an accidental machine start-up. It is important that the training be specific to the equipment operated. Elements of the training include the following:

a. The recognition of lock/tagout devices and the importance of not disturbing or removing them unless authorized.

b. The safe application, use and removal of energy controls.

c. The limitation of energy control identification tags in a lockout/tagout procedure (Bean & Lawrence, 1999).

Audits, Inspections and Checklists

Periodic inspections are another important element in the control of hazardous energy and protecting employees from moving machinery. The inspections should be conducted at least annually to ensure that the requirements of the program and standards are being followed. The inspections should focus on identifying and correcting hazards or deviations from established standards. The inspections must also review each authorized employee's ability to perform his or her assigned tasks as identified under the program. The employer must certify that the periodic inspections are performed, and that they identify the machine or equipment on which the energy control procedures were conducted. Criteria should include the date of the inspection, employees monitored, and the name of the inspector (Becker & Stephenson, 2002).

Policies and Procedures

Policies and procedures for applying lock-out/tag-out need to be developed and clearly communicated to employees. The procedures should be specific to the equipment and machinery that is used and follow the specifications defined in the OSHA lock-out/tag-out standard. One checklist researched identifies energy control procedures in a sequential order, from shut-down to start-up (Lockout blockout procedures, 2002). Specific energy control procedures should be prepared for each piece of applicable equipment. Components described in the procedures should include their purpose, compliance aspects, the sequence of lockout, and restoring equipment to service.

Written Programs

Written lock-out/tag-out programs should contain elements that analyze the hazards in the workplace and include energy control procedures, employee training, periodic inspections and a tag-out system. The written energy controls should clearly identify specific steps for shutting down, working on, and activating the equipment.

The plan should address conditions where energy control is not needed and also describe the employee training process (Lockout/tagout, 2002). Elements required in the written programs include the following:

1. A specific statement as to the intent of the program
2. Specific steps for shutting down and blocking equipment to control hazardous energy
3. Specific procedures for placing and removing locks
4. Requirements for verifying the lockout/tagout and testing procedures
5. A detailed training program for authorized and affected employees
6. Descriptions of company policies regarding special situations, including group lockouts and the application of lock-out/tag-out procedures performed by outside contractors (Bean & Lawrence, 1999).

Equipment and Criteria for Lock-out/tag-out Devices

Protective energy control materials and hardware include: locks, tags chains, wedges, key blocks, adapter pins, self-locking fasteners and other devices for isolating, securing or blocking machines or equipment from energy sources. The use of equipment and devices is critical to the success of implementing lock-out/tag-out and machine guarding measures to protect employees. Regarding protective materials and hardware, the following recommendations are made:

1. They must be durable
2. They must be standardized
3. They must be substantial
4. They must be identifiable (Becker & Stephenson, 2002).

Subject Selection and Description

Subjects for the evaluation were selected from established operators who worked on the XYZ Company production lines. Many of the operators were veterans who had

worked at the facility for over 10 years. There were however, several new operators hired from 2000 to 2002. Many of the production lines had been in operation for over 20 years. Modifications to the existing lines had occurred from 1997 to 2002, designed to improve operating efficiency and production capabilities. The new equipment brought improved machine guarding and determined lock-out/tag-out points. The operators completed annual training on lock-out/tag-out and were considered authorized to apply lock-out/tag-out on their machines.

Operators were trained and qualified to operate each individual line. They must have completed both a written and practical test to demonstrate competence in operating the equipment. General operating procedures were established defining the tasks and activities required by the operators to run the particular lines. Safe practices and safe procedures were incorporated into the general operating guidelines.

Deficiencies and Risk

Conducting observations of the operating lines, along with reviewing accident logs, revealed several deficiencies and hazards. Combined, they present a situation that could be considered out of control, regarding the ability to provide a safe working environment. The possibility also exists for another catastrophic event similar to the ones that occurred in 1994 and 1995. The deficiencies observed included the following:

1. A lack of enforcing established safe practices
2. A lack of enforcing established safe procedures
3. Conflicting messages and communications which may be perceived as placing a higher priority toward reaching production standards verses ensuring personal safety
4. Inconsistencies in the written program and hardware (locks and tags)
5. Inadequate training and certification for demonstrating competence
6. Incomplete auditing or monitoring of employee compliance with company regulatory standards toward machine guarding and lock-out/tag-out.

The instruments described in the next section will attempt to measure employee performance, management accountability, and assist to help reduce the deficiencies and causation that have produced the injuries and losses associated from contact with moving equipment.

Instrumentation

Several instruments have been prepared that will evaluate and measure the risk involving contact with moving equipment. The instruments are designed to measure the following variables:

1. The level of competency of operators who apply lock-out/tag-out
2. The physical conditions and working environment
3. The degree of supervision and feedback from management staff to achieving compliance with machine guarding and lock-out/tag-out standards.

Several instruments will be applied for conducting a risk evaluation.

The instruments utilized in this study to measure risk include:
A General Working Environment Survey, Overall Facility Rating Score, Lock-out/tag-out Audits, Lock-out/tag-out Job Safety Analyses, Lock-out/tag-out Behavioral Audits, and Lock-out/Tag-out Certification and Qualification.

Summary

This literature review has focused on identifying conditions and events that have resulted in injuries from employee contact with energy or moving equipment. While the accidents described were tragic, they were largely preventable, as determined by the analyses provided from the accident investigations. Recommendations were often specific to the situation, such as providing proper machine guarding or establishing practical energy control procedures. It is also important to implement a comprehensive and on-going energy control program.

General policies and procedures can help convince employees to comply with company guidelines. In many cases, employee training can be measured through follow-up inspections and audits. Checklists can be prepared and utilized in the auditing process. One such checklist is outlined below:

A Checklist for Compliance with the Lock/Tagout Standard:

1. Audit machinery and equipment for types of energy and potential hazards
2. Identify and document equipment that involve lock/tag-out procedures
3. Identify and document, by name and by job title, all authorized and affected employees
4. Describe and document types and locations of energy isolating devices and equipment
5. Describe and document the types of energy involved and the methods to be used to dissipate or control energy in all applicable equipment
6. Describe methods established to isolate the energy and any additional safety measures
7. Develop a written lockout/tagout program (Bean & Lawrence, 1999).

CHAPTER THREE

Methodology

Introduction

This chapter describes instruments and evaluative tools applied to measure employee and company compliance with applicable OSHA lock-out/tag-out and machine guarding regulations. The six instruments employed in the study surveyed, audited and analyzed company, as well as individual employee performance. The objective of engaging these instruments was to recognize unsafe conditions and correct unsafe actions, in order to minimize the potential of an accident resulting from exposure to energized or unguarded equipment.

The purpose of using these instruments was to support the statement of the problem presented in Chapter One. That is, correcting recognized hazards reduces the risk of employee exposure to energized or guarded equipment. The instruments used in this study measured both working conditions and employee acts. Areas analyzed included employee behaviors (such as applying energy controls), the work environment (such as housekeeping), the wearing of required personal protective equipment (PPE), and communications systems (such as signs, labels and two-way radios).

A brief outline of the six instruments utilized in this study follows. A description of how they were applied is also included.

1. The General Working Environment Survey measured working conditions and employee behavior over five general categories. The observer answered general questions listed on the checklist and determined whether the condition or behavior observed was either ‘safe’, or ‘at risk’. If the observation was determined as safe, a mark under the ‘safe’ column was made. Points were awarded for the particular question (and category). At the end of the survey, a formula was used to calculate an overall score comprising the entire list of questions. The reason this survey was chosen

was because of two specific questions relevant to the study. One was question 3.5: 'Machine Guarding in Place'. The question(s) read: 'Are all guards in place? Are safety switches and doors in proper working order?' The other was question 4.5, focusing on lock-out/tag-out. The question read: 'Are lock-out/tag-out procedures being used and audited?' Responses to these two questions were analyzed across a series of recorded observations.

2. The Overall Facility Rating Score evaluated the company against nine primary venues. One was 'Standards implementation'. One of the 19 areas measured under this core element presented seven questions relating to lock-out/tag-out. The questions specifically measured compliance with established OSHA lock-out/tag-out regulations. Receiving an affirmative (positive) score required proof and documentation of the point being verified. The questions asked for confirmation of whether written programs, procedures, employee training, and audits were being regularly conducted.

3. Lock-out/tag-out Audits focused on the XYZ Company's ability to comply with regulations and requirements established in OSHA's lock-out/tag-out standard. This audit was designed to measure direct compliance with OSHA standards. It also applied a scoring system of awarding points for an affirmative or 'yes' reply under Section one.

Unique to this instrument was a series of questions asked in section two. Inquiries from this section sought deficiencies in the company's lock-out/tag-out plan. A 'yes' reply indicated an area of potential risk. If an affirmative response was noted, significant points were deducted from the overall score (by a factor of five to one over section one). Furthermore, a corrective action plan was required if a negative or 'no' answer was given. Points were totaled in section two. The difference from deducting points received from section two against the points earned in section one resulted in the overall audit score.

4. Lock-out/tag-out Job Safety Analyses were descriptions of individual tasks. Each one was structured systematically, presenting first a sequence of basic job steps. Potential hazards were identified for each corresponding job step. Recommended safe procedures for performing the steps were referenced, associated with the job steps. Unlike the first three instruments, Lock-out/tag-out Job Safety Analyses did not utilize a scoring system for awarding points. The instrument defined expected performance standards for conducting the job tasks or duties.

5. Lock-out/tag-out behavioral audits evolved from the Lock-out-tag-out Job Safety Analyses. 'Recommended Safe Procedures' listed specific methods for safely performing the required tasks. An observer would monitor and compare an employee's performance against the listed safe procedures. The employee would then receive feedback from the observer in regards to whether they followed the correct procedures.

If the employee deviated from the established performance standards, the observer would provide corrective feedback, in order to reinforce the correct or established standards. No score or points were awarded. The objective of performing these audits was to establish a habit and practice of continuous safe performance. An analogy would be on instructing people to wear seat belts. Positive reinforcement (along with consequences for non-compliance) can be provided. The goal is to convince the person to 'buckle-up' as a matter of habit, without the need for continuous reinforcement.

6. The Employee Lock-out/tag-out Certification contained a sequence of steps for employees to correctly perform a practical application of learned energy control skills. The objective was to verify the individual's application of lock-out/tag-out steps on a particular piece of machinery. The person would follow the lock-out/tag-out sequence as directed by a 'coach'. This could be a member of management or fellow employee. The employee would demonstrate the action requested in order to receive a check in the box defining the skill or knowledge displayed. The goal would be for the person to complete

certifications on all machinery or equipment that they would be expected to control or lock-out. Positive reinforcement or corrective recommendations could be provided by the 'coach' or evaluator. Like the behavioral audits (instrument number 5), continuous application of safe performance would be sought. This would lead to recognizing lock-out/tag-out situations and applying energy control as a regular course of action.

Data Collection

All instruments described supplied data that was collected and analyzed. The instruments were tested at the XYZ Company, measuring employee performance with planned objectives. When derived, scores were calculated and compared with objectives for reaching and maintaining minimum standards.

Data Analysis

Data gathered from the six instruments was utilized to report findings and provide recommendations. This was presented through quantitative and qualitative means. Relevance and trends were determined when the instruments were conducted over time. It is possible that data results might be utilized to predict or project possible losses based on observable conditions or behaviors.

Scoring and Statistical Analysis

Recommendations presented later in this report will be generated based on the data collected and analyzed. The recommendations will be measured and reported statistically. The General Working Environment Survey produces a total of up to 100%. On the Overall Facility Rating Score, the seven lock-out/tag-out questions comprised a percentage of the 190 total questions. Once completed, the total of all correct responses was calculated and a score was assigned.

Another score was calculated when applying the Lock-out/tag-out Audit. In this instrument, the highest achievable score was 200 points. The objective was to receive

positive scores on the first section of the audit, while minimizing penalty points deducted from receiving 'yes' answers on section two, identifying deficiencies in the program.

The Lock-out/tag-out Behavioral Audits were used to supply quantitative data. Recorded observations tended to predict future behaviors. If a pattern emerged (where repeated unsafe behaviors were directly observed), this indicated a potential for future loss. An unsafe activity could lead to employee injury resulting from contact with moving equipment. The goal was to reach a score of 90% of the audits being successfully observed. That is, 90% of the employees observed should have been performing correct behaviors as described on the behavioral audit.

The Lock-out/tag-out Certifications were awarded based on qualitative data as well. The observer conducting the lock-out/tag-out certification would measure employee performance as compared with the skills listed. A successful demonstration of the lock-out/tag-out steps would lead to the employee earning the certification for the particular equipment on which they practiced their lock-out/tag-out skills.

Limitations

Each of the instruments proposed posed limitations in data collection and accuracy. The General Working Environment Survey and the Overall Facility Rating Score were both qualitative in nature. There may have been inaccuracies present, and being subjective, they may have not been consistently reliable, as they were subjective to the person applying the instrument. Unless the instruments were consistently applied by the same evaluator, different conclusions for the same observed conditions also could have been reached. This limitation could have addressed through training (inter-rater reliability.

Questions and scoring from conducting the Lock-out/tag-out Audits presented limitations as well. The questions may have been interpreted differently by the observer,

causing scoring discrepancies. There may have been a bias by the scorer, especially if the audits were conducted by XYZ Company employees.

Data analyzed from Lock-out/tag-out Job Safety Analyses may have been potentially unreliable, as determinations for safe or unsafe procedures could have been open to interpretation by persons who placed other priorities above safety, and therefore minimized the risks or hazards associated with performing the tasks.

Data collected and analysis from the Lock-out/tag-out Behavioral Audits may also have been subject to misinterpretation. A large sample of behavioral audits (minimum of 1200) is generally recognized as being necessary to reasonably predict accurate forecasting or trends. Since the behavioral audits were conducted based on observable behaviors, they were also open to attitude, judgment, or reporting errors.

Employees successfully completing lock-out/tag-out certifications may have demonstrated competency during the 'test' period observed, but there is question as to whether or not they would continue to apply safe practices when they knew that no one would be observing them. Thus, 'successful observations and their resulting scores could lead to inflated averages.

A general limitation to the study was the small population sampled. While the number of instruments provided a cross-section of observable data, the information was limited to XYZ employees. Comparisons could be made with employees from other companies under similar circumstances (such as in the literature review). However, the statistical number and resulting data was comprised solely of XYZ employees. The pool of observers was also limited to XYZ staff, or other company officials who collected data using the instruments supplied. The data may have been considered more reliable if it was collected from outside, unbiased individuals not directly associated with the XYZ Company.

Summary

This chapter emphasized the importance of utilizing instruments to quantify, as well as qualify data aimed at analyzing the XYZ Company's risk for injuries resulting from contact with moving or energized machinery. The data collected was both broad-based and precise. Certain instruments measured general trends and patterns. Other evaluative tools determined individual performance and skill retention. Results from the findings will be reported in Chapter Four.

Chapter Five will discuss the results and attempt to draw conclusions and provide recommendations for reducing at-risk behaviors and preventing employee injuries. The objective of this study was to recommend methods for improving employee compliance and recognition to established safe practices, leading to improvements in the XYZ Company's overall safety and health process.

CHAPTER FOUR

Results and Discussion

Introduction

This chapter will report on data received based on the results of the tests and instruments described in Chapter Three. An attempt will be made to answer the three main objectives of the study:

1. To assess the current level of risk of accidents and injuries occurring to XYZ Company employees.

2. To identify best practices for companies and employees operating or working around industrial equipment.

3. To determine controls and processes to prevent further losses or exposure.

Findings collected from the instruments will be discussed. The instruments will be measured based on their ability to answer the objectives. An overall summary and review will close Chapter Four, leading to the discussion, conclusions and recommendations presented in Chapter Five.

Demographics Information

The XYZ Company employs up to 500 full time workers in its factory. 95% of the employees live within 50 miles of the facility. Approximately 58% of the employees are female and 42% are male. There are 410 hourly employees directly involved in the manufacturing process. There are 30 office and administrative support personnel. The other 60 employees comprise supervisory and management staff.

Approximately 180 hourly employees are considered ‘authorized’ to perform lock-out/tag-out. This group consists of machine operators and maintenance personnel. An authorized employee is defined as one who is allowed to enter and perform energy control on powered or moving equipment. All other hourly employees and staff are

considered ‘affected. They do not directly work with moving or energized equipment, but could become exposed or injured to energized machinery under certain conditions.

Accident History

A review of accidents described in Figures 1 and 2, involving contact with uncontrolled energy or unguarded equipment produced the results reported in Figure 4.

Figure 4: Employee Data Based on Reported Accidents

Date of Accident	Experience	Authorized or Affected	Department
1994	> 10 years	Authorized	Production 3
1995	< 1 year	Affected	Production 3
2/01	> 10 years	Authorized	Production 3
2/01	> 1 year	Affected	Production 1
7/01	> 10 years	Affected	Production 2
1/02	> 10 years	Authorized	Production 3
4/02	> 10 years	Authorized	Production 3

Employees injured in these accidents had either worked less than one year, or greater than ten years. The majority of the accidents (five out of the seven reported in this study) occurred in the Production 3 department.

Training

XYZ Company employees are required to attend annual awareness training in lock-out/tag-out. During the training, they review the company’s lock-out/tag-out program, along with the basics of energy control. Employees also receive annual training on machine guarding. This course is conducted separately from lock-out/tag-out and presents concepts, such as protecting employees from exposure to moving parts.

Employees whose tasks include applying energy control engage in additional authorized lock-out/tag-out instruction. This training involves the practical application of locks and tags. As part of the training, authorized employees are required to perform a simulated sequence involving each of the lock-out/tag-out steps.

Item Analysis

Results from the six instruments used to collect, test and measure data will be reported, regarding their ability to answer the three objectives of the study. The sequence of the instruments presented will proceed from general and global, narrowing down and becoming more specific and individualized. Data will be reported comparing the XYZ Company as a whole, its six departments, and individual (though anonymous) employees, to the study's objectives.

The General Working Environment Survey (Attachment 1)

The General Working Environment Survey measures conditions and employee practices across a wide range of areas. The instrument serves to gauge the level of safety observed in the facility at a given time. Observations and responses are judged based upon independent observations. There are five sections with five questions each, for a total of 25 questions.

A total of 21 surveys were conducted in the facility, covering a three-month period from September 2002 to November 2002. The audit process consisted of measuring the facility's six departments separately, and conducting an overall plant survey.

When an indicator was marked as 'safe', five points were awarded. If the question was checked as 'at risk', no points were given. Scores were calculated based on the number of 'safe' checks. Results from the overall survey are reported in Figure 5.

Figure 5: Results from General Working Environment Surveys: Total Scores

Department	Baseline	Month 2	Month 3
Production 1	85	88	92
Production 2	80	85	82
Production 3	70	75	80
Maintenance	60	80	80
Warehouse	70	75	80
Cleaning	80	85	90
Overall	75	80	80
Average	74.28	81.14	83.43

Discussion:

A gradual, collective improvement occurred over the three-month period, as evidenced by the increase in the average scores. Every department realized an improvement from the original baseline score to the month 3 score. The highest total score was achieved by the Production 1department. The greatest overall improvement from the baseline score to the month 3 period occurred in the Maintenance department.

The surveys evaluated working conditions and employee behavior across several safety functions. Two items related specifically to the objectives of this study. The first referred to machine guarding and was listed as question 3.5. The questions asked were: 'Are all guards in place? Are safety switches and doors in proper working order?' Results from question 3.5 are displayed in Figure 6. The second item, 4.3, was directed at lock-out/tag-out. The question asked: 'Are lock/tag-out procedures being used and followed?' Results from answers to item 4.3 are reported in Figure 7.

Figure 6: Results from Question 3.5 on General 3 Working Environment Surveys

Department	Question 3.5 Baseline	Month 2	Month 3
Production 1	safe	safe	safe
Production 2	at-risk	at risk	safe
Production 3	at risk	safe	at risk
Maintenance	safe	safe	safe
Warehouse	safe	safe	safe
Cleaning	safe	safe	safe
Overall	at risk	safe	safe

Figure 7: Results from Question 4.3 on General 3 Working Environment Surveys

Department	Question 3.5 Baseline	Month 2	Month 3
Production 1	safe	safe	safe
Production 2	at-risk	at risk	safe
Production 3	at risk	at risk	at risk
Maintenance	safe	safe	safe
Warehouse	safe	safe	safe
Cleaning	safe	safe	safe
Overall	at risk	at risk	safe

Relationship to Study Objectives:

Results from the survey indicate that the Production 2 and 3 departments presented risks to possible injury by receiving ‘at risk’ responses in both of the questions on each of the surveys performed. The ‘at risk’ marks were based on observations of

missing machine guards and equipment controls not verified to be in complete working order. A 'yes' reply from observing respondents would indicate the demonstration of best practices by employees working around industrial equipment.

Receiving scores of 90% on the survey could lead to improvements in working conditions and employee behavior. The prevention of further losses or exposure to moving or unguarded equipment could be maximized by establishing a continuing trend-line of safe observations in questions 3.5 and 4.3.

The Overall Facility Rating Score (Attachment 2)

This rating is conducted quarterly and measures the scope of compliance in regulatory (OSHA) safety and health. There are 19 sections on the rating, each one focusing on a particular regulatory aspect. Points are awarded for receiving positive or affirmative answers. A total is compiled based on and the overall score of the 19 sections. A rating is then assigned on a weighted scale of between one and ten. Section 15, titled 'The Control of Hazardous Energy', contains seven questions pertinent to lock-out/tag-out. The questions are set up in a 'yes' or 'no' format.

The evaluator verifies whether the facility receives a 'yes' answer based on documented responses. Figure 8 lists the questions and illustrates the progression of the XYZ Company's scores taken quarterly by this study's author throughout the course of one year. The first rating was conducted prior to commencing the study in January 2002. The 2nd rating was conducted in April 2002. The 3rd rating was completed in July 2002. The 4th rating was performed in November 2002. This study was concluded in November 2002. The full text of the questions is found in Attachment 2.

Figure 8: Results from Overall Facility Rating Scores

	1st Rating	2nd Rating	3rd Rating	4th Rating
Question 15.1: Written energy control program, procedures and employee training	No	No	Yes	Yes
Question 15.2: Annual lock-out/tag-out training	No	No	No	Yes
Question 15.3: Employees issued individual locks and tags, an inventory program exists	No	No	Yes	Yes
Question 15.4: Written lock removal procedure	No	Yes	Yes	Yes
Question 15.5: Lock-out/tag-out audits conducted to verify employee compliance	No	No	No	Yes
Question 15.6: Lock-out/tag-out performed on all types of energy	No	No	Yes	Yes
Question 15.7: Lock and tag-out direct energy source	No	No	No	Yes

Discussion

The XYZ Company achieved improvements across the series of ratings conducted during the year. At the time the study was initiated, there was no established written energy control program. The company relied on a 'boiler-plate' or generic plan. As the year progressed, specific procedures were developed for employees when working with energized equipment. Instructions indicating specific energy control steps were placed on the machines and employees received training on the energy control procedures.

Relationship to Study Objectives:

The seven questions in the rating define the elements required for compliance with OSHA lock-out/tag-out regulations. Results from the first and second ratings produced low averages and indicated a risk of exposure to injury from uncontrolled energy or unguarded equipment. Scores from the third and fourth ratings improved, leading to greater emphasis on compliance, and reducing the level of risk as compared with the earlier scores. The averages from each rating are reported on Figure 9.

Figure 9: Averages from Overall Facility Rating Scores

	1st Rating	2nd Rating	3rd Rating	4th Rating
Individual Period	0	14.3%	57.1%	100%
Cumulative	0	7.1%	23.8%	46.4%

The questions on the rating identify best practices for employees working around industrial equipment. By receiving positive responses to all of the questions in the 4th rating, the XYZ Company instituted all seven best practices across each of the departments, and in the company as a whole. Establishing controls such as a written program, employee training, verified procedures and regular audits served as controls for helping to prevent future losses or exposure.

Chapter Five will analyze these findings further, and indicate any correlation with previous injuries and the lack of documented energy control procedures and practices.

Lock-out/Tag-out Audits (Attachment 3)

Conducting lock-out/tag-out audits can be a direct method for determining adherence to prescribed safe practices and principles. The audit evaluated the system of lock-out/tag-out and identified the ability of employees to conform to established energy control policies and procedures. It was utilized as a direct measurement for

monitoring on-going compliance with established energy control procedures. The questions focused on employee knowledge and practices. The audits were conducted quarterly.

The Lock-out/Tag-out Audit is divided into two sections. Section I measures regulatory compliance. There are nine categories and 40 questions in Section I. A list of the categories is described in Figure 10. Five points were awarded for receiving a 'yes' or affirmative answer. A 'no' response resulted in 0 points for the item. Similar to the Overall Facility Rating Score, documentation was required to verify compliance and earn points. By receiving affirmative answers to all questions, the company could compile a maximum of 200 points.

Figure 10: List of Section I Categories on Lock-out/Tag-out Audits

Category	Number of Questions
Review of Plan	2
Training and Certification within Last Year	5
Employee Monitoring	3
Locks and Tags	7
Labeling	2
Equipment	4
Safe Practices and Procedures	7
Application	7
Starting Back Up	3
Total Questions	40

Section II of the audit identified any deficiencies in the company's lock-out/tag-out process. There are eight questions asked in this section. Affirmative answers

(indicating program flaws and therefore risks to exposure) are worth 25 points. These questions are weighted higher than those in Section I, because they indicate risks present that could lead to exposure to uncontrolled energy (and consequently lock-out/tag-out related injuries). A possible 200 points could be deducted in Section II.

The points accumulated from Section II were subtracted from the points awarded in Section I to arrive at the total score. Because of the balanced scoring, it was possible to obtain an overall negative score. Figure 11 represents a summary of the questions (identifying deficiencies) asked in Section II.

Figure 11: Summary of Questions Asked from Section II, Lock-out/Tag-out Audits

Question
Evidence of overriding or defeating energy controls
Unauthorized employees entering equipment under lock-out/tag-out conditions
Employees unclear of when to apply lock-out/tag-out
Covering of cycle or emergency stops considered as lock-out/tag-out
Clearing jams without applying any energy controls
Evidence of incidents or close calls involving lock-out/tag-out violations
Employees use interlock doors without applying energy control

Audits were conducted quarterly, to correspond with the Overall Facility Rating Scores. The audits were conducted in each of the company's departments. Figure 12 presents the results collected during 2002. The ratings were conducted as follows: Rating 1, January, Rating 2, April, Rating 3, July, Rating 4: November.

Figure 12: Scores from Lock-out/Tag-out Audits

Department	Rating 1	Rating 2	Rating 3	Rating 4	Increase
Production 1	25	40	75	100	+75
Production 2	-55	-25	0	50	+105
Production 3	-65	-20	40	25	+90
Maintenance	0	35	60	130	+130
Warehouse	55	75	85	90	+35
Cleaning	80	95	105	120	+40
Overall	-45	-10	-5	50	+95

Discussion:

The lock-out/tag-out audits displayed similar patterns to the Facility Ratings Scores. The Rating 1 scores suggested a lack of understanding or documentation regarding energy control. The audits improved over the duration of the study, with the last quarter representing the highest department and plant scores. The Maintenance department provided the highest overall score, and also the greatest improvement during the year. The overall company score was rated separately, not compiled based on cumulative department audits.

The Production 3 department received the lowest period 4 rating and least improvement. The Production 3 department was also the only one to have a reduced rating from the third to the fourth period. The XYZ Company progressed during the year, reversing a negative first period score to reach a positive rating by the 4th period.

Relationship to Study Objectives:

The XYZ Company achieved a negative cumulative score throughout the first three periods. This represented multiple deficiencies in the company's energy control

program. Receiving replies in any of the eight deficiencies would indicate a risk of a lock-out/tag-out related injury or accident occurring. The overall level of risk decreased each quarter as the audits were conducted. Based on the data collected, Production 3 department employees would appear to have the greatest risk for an injury, and the Maintenance employees would appear to be least at risk. Data from Figure 13 illustrates the number and corresponding deductions from the deficiencies identified in Section II.

Figure 13: Deficiencies and Corresponding Scores from Section II

Department	Rating 1	Rating 2	Rating 3	Rating 4
Production 1	3 (75)	2 (50)	1 (25)	0 (0)
Production 2	4 (100)	3 (75)	2 (50)	1 (25)
Production 3	5 (125)	4 (100)	2 (50)	3 (75)
Maintenance	2 (50)	1 (25)	0 (0)	0 (0)
Warehouse	2 (50)	2 (50)	1 (25)	0 (0)
Cleaning	1 (25)	1 (25)	0 (0)	0 (0)
Overall	3 (75)	2 (50)	1 (25)	3 (75)

There is also relevance in the types of deficiencies reported in the study. The primary causes identified from the injuries described in Chapter 1 of this study (Figures 1 and 2) resulted from two of the deficiencies, described as questions:

1) Do employees clear jams without applying any energy controls?

2) During the process of clearing jams, could equipment accidentally energize?

Figure 14 presents results collected from the XYZ Company's audits comparing replies to these two specific questions. Based on the data collected, the XYZ Company would appear by Rating 4, to have reduced the risk for accidents or injuries occurring associated from these two specific activities.

Figure 14: Replies from Specific Deficiencies Reported

	Rating 1	Rating 2	Rating 3	Rating 4
Clearing jams without energy controls	yes	yes	yes	no
Accidental start-up while clearing jams	yes	no	yes	no

Lock-out/Tag-out Job Safety Analyses (Attachment 4)

This instrument was utilized to define acceptable practices and procedures for working with and around energized and moving equipment. Distinct job safety analysis (JSA's) were developed for each of the functions requiring control of hazardous energy. Completion of the JSA's indicated an understanding of the jobs and duties requiring energy control. At the start of the study, no JSA's had been defined or developed. There were general energy control procedures, but none were prepared for any individual operating equipment.

The purpose of developing JSA's was to identify potential hazards, and recommend procedures for safely performing assigned tasks. A key strategy identified in the XYZ Company's 2002 safety plan was to design a comprehensive list of JSA's relating to working with and around energized equipment. Figure 15 illustrates the number of lock-out/tag-out related JSA's developed during the course of the study. Development of JSA's is an on-going process.

Figure 15: Development of Energy Control Job Safety Analyses

Department	Start of Study, January 2002	Completion of Study, November 2002
Production 1	0	25
Production 2	0	31
Production 3	0	16
Maintenance	0	71
Warehouse	0	15
Cleaning	0	13
Total	0	171

The 171 audits completed represented a portion of the total pool. It is estimated that there are over 400 different jobs in the facility, so the current number represents about 43% of the total amount. There could also be duplication across jobs, such as in the three production departments. The JSA development process includes an annual review and re-issuance for each job.

Discussion

The JSA development process required the need to Identify specific lock-out/tag-out job functions. Determining conditions and procedures for applying energy control devices was integral to reducing the risk of exposure and injury under lock-out/tag-out situations. One goal following the completion of this study was to continue to produce JSA's for all functions, until all job tasks were identified and completed. A number was issued for each JSA and an inventory was established for reference.

The quality of the JSA's was also evaluated during the course of the study. Employee and management teams reviewed the completed JSA's. In many cases, the JSA's were either revised or discarded following this peer review. The acceptance of a

completed JSA required it to be 'field tested'. That is, the sequence of job steps had to be duplicated and capable of being conducted.

The job steps needed to be realistic, brief and simple to perform. Identified hazards were recognized as being present, or having caused a previous accident from performing the activity. This was a critical section, as one of the objectives of the study was to prevent future injuries and losses from energized or moving equipment.

Relationship to Study Objectives:

Developing JSA's for defining safe procedures when working with energized or guarded equipment would help reduce the level of risk for accidents and injuries occurring to XYZ employees. Listing the basic job steps would aid in explaining the sequence of activities in a logical manner.

Identifying hazards would help workers avoid situations and circumstances that could produce a work-related injury or illness. Following the recommended safe job procedures would help improve operational efficiency and increase the ability of workers to perform their assigned tasks consistently and safely.

The purpose of a JSA is to determine safe procedures. The safe procedures can be interpreted as best practices in this study, for working with and around industrial equipment. The JSA seeks continuity over individual variation. Involving employees in the development of JSA's helps to establish credibility in ascertaining accurate steps and procedures.

By its design, the JSA is a functional tool for controlling the specific job process. There were two critical reasons that this tool was chosen. One was to identify – and correct potential hazards. The other was to define the safe procedures that employees could follow in order to prevent exposure to hazards and subsequent injury or loss.

Lock-out/tag-out Behavioral Audits (Attachment 5)

The third column of the JSA – 'Recommended Safe Job Procedures', was copied onto a separate form, called a behavioral audit, or safety check (the terms will be used interchangeably). Where the JSA identified hazards and safe procedures, the behavioral audit was used to observe employee performance, and ultimately, compliance with the established safe procedures. As a part of the study, behavioral audits were developed for each of the JSA's produced.

The recommended safe procedures coincided with the sequence of job steps listed on the corresponding JSA's. The purpose of performing the behavioral audits was to measure employee performance, indicating positive (acceptable), or negative (at risk) behaviors. The process of conducting a behavioral audit consisted of a trained observer walking out to the work area with one of the forms. The observer watched an employee perform the activities listed on the individual safety check.

The observer would evaluate whether or not the employee performed the tasks safely, as defined on the audit form. If the employee capably performed the task, a check was placed in the 'yes' box for the particular activity observed. If the task was performed differently (unless there was an acceptable alternative for performing the task), the observer placed a check in the 'no' box. There was also a 'comments' box, where the observer could indicate any views or recommendations.

An important component of the behavioral audit was to provide immediate feedback to the employee being observed. Feedback was accomplished through an open, two-way system of communications. If the employee performed the job successfully, he or she would receive positive, complimentary feedback. If at-risk behaviors were observed, corrective actions could be offered.

Results from the behavioral audits could then be measured and calculated. Trends or patterns of unsafe practices could be identified and addressed in order to

prevent employee injury. These audits could be utilized as a predictive tool, to identify and correct potential unsafe acts before an accident occurred. Figure 16 represents the data collected from the completed audits.

Figure 16: Results from Lock-out/Tag-out Behavioral Audits

Department	Audits Conducted	Successful	At-risk	Percentage Successful
Production 1	42	38	4	90.4%
Production 2	24	22	2	91.7%
Production 3	16	10	6	62.5%
Maintenance	32	31	1	96.9%
Warehouse	10	10	0	100%
Cleaning	13	10	3	76.9%
Total	137	121	16	88.3%

The observer could demonstrate to the employee, the correct or safe method for controlling or isolating the energy source. One of the goals of the behavioral audits was for employees to observe and provide feedback to their fellow workers. Employees did perform behavioral audits in the Maintenance department during the course of this study. Behavioral audits were conducted by either management or supervisory personnel in the other five departments.

The XYZ Company began conducting the audits in September 2002. Audits were conducted in all of the departments at various dates and times. The audits were performed on several employees, although they were anonymous and did not identify the specific individuals observed. The numbers displayed in Figure 16 represent audits conducted from September 2002 through November 2002.

A successful audit was deemed as having all of the listed steps as being safely performed. An at-risk audit was identified when one or more of the steps were observed as being potentially unsafe. The audits in Figure 16 measured observations of lock-out/tag-out activities.

Discussion

The audit findings show a potential risk of unsafe behaviors. Employees working in the Production 3 Department appeared to be most at risk, as the highest number and percentage of unsafe behaviors were observed in this department. The trends and patterns of unsafe behaviors observed are presented in Figure 17. Of the 16 unsafe observations, the one most frequently cited was not applying a lock or tag. Performing any of the unsafe observations could have resulted in an exposure to hazardous energy.

Figure 17: Unsafe Behaviors Observed from Lock-out/Tag-out Behavioral Audits

Observed Act	Number of Observations
Not applying a lock or tag	6
Not notifying affected persons	4
Not testing for stored energy	3
Leaving equipment or tools on machine	2
Applying tag without lock	2

Relationship to Study Objectives:

The current level of risk for an accident associated with lock-out/tag-out could be accurately measured by evaluating the completed safety checks. Recording the unsafe behaviors (listed in Figure 16) would focus on potential risks that could lead to injuries.

Positive (safe) observations could become best practices, and serve as training guides to assist employees who have been observed unsafely performing selected

behavioral audits. The results could then become a predictive means for evaluating the risk of future injuries by reporting unsafe acts or practices before an accident occurred.

Employee Lock-out/Tag-out Certifications (Attachment 6)

The Employee Lock-out/tag-out Certification represented the most direct method of measuring (and building) correct, individual performance. The objective of the certifications was to provide a means of for employees to learn and apply practical energy control skills on specific equipment. The certifications consisted of 14 questions, representing the steps of applying and disengaging the lock-out/tag-out sequence. A trained evaluator coached or prompted the employee through each of the defined steps.

The certification would be performed through stages, from the start of the process, to completion. Once all steps were observed to be safely performed, the employee would be considered as being certified to perform lock-out/tag-out on the particular piece of equipment observed. The goal was to perform lock-out/tag-out certifications for every authorized employee on each piece of machinery that they were authorized.

Figure 18 comprised the results from the certifications performed from March 2002 through November 2002. Successful certifications indicated that the employee satisfactorily completed all of the 14 steps. An unsuccessful attempt indicated that one or more of the steps were not performed safely or as described.

Figure 18: Lock-out/Tag-out Certifications Performed

Department	Certifications	Successful	Unsuccessful
Production 1	16	15	1
Production 2	20	19	1
Production 3	18	14	4
Maintenance	37	37	0
Warehouse	10	8	2
Cleaning	12	12	0
Total	113	105	8

Discussion

Of the 113 certifications performed, 105, or 92.9% were observed as being successful. Employees who did not initially receive a successful certification were allowed to repeat the steps. A total of 52 employees completed the certifications during the study. Although there were eight unsuccessful occurrences, all observed employees did eventually receive successful certifications.

Relationship to Study Objectives:

Verifying that employees demonstrated the correct and accepted methods for performing lock-out/tag-out would work to reduce the risk of accidents and injuries occurring from contact with uncontrolled energy. The purpose of applying the instrument was to first instruct, then measure the ability of employees to perform lock-out/tag-out on the machines and equipment they were assigned. Demonstrating competency in performing energy control on specific equipment would be a best (safe) practice for completing the required tasks. The certifications were distinct controls designed to help prevent further losses or exposure.

Summary

The six instruments utilized in this study evaluated various elements of the XYZ Company's machine guarding and energy control programs. Some of the tools were more global in scope, measuring performance and verifying compliance with regulatory standards. Other audits analyzed job tasks and monitored individual employee skills in lock-out/tag-out. The results collected indicate inconsistencies in program administration and continuity.

The degree that such results and variances predict increases in the level of risk and subsequent injury will be presented in Chapter Five. The concluding chapter will examine the level of risk based upon the interpretation of the data collected.

CHAPTER FIVE

Discussion, Conclusions, and Recommendations

Introduction

This chapter will evaluate the results collected in Chapter Four, based upon data collected from the instruments described in Chapter Three. The data and observations will be compared with research conducted and reported in Chapter Two. A discussion of the findings reported will elaborate on previous research data. Conclusions will be drawn summarizing the results received from utilizing the six instruments applied during this study. Recommendations will be provided to conclude the study, indicating methods for improving the company's energy control program and reducing the possibility of employee contact with energized and moving equipment.

Results and Discussion

A review of literature described in Chapter Two reported on injuries and losses associated from employee contact with moving or energized equipment. In many of these cases, there was a direct link between competent employee knowledge (of required safe actions), and the incidence of lock-out/tag-out related injuries. A summary of the conclusions drawn from the cases reported indicated the deficiencies and contributory factors listed in Figure 19. They can be displayed as direct or root causes.

Figure 19: Basic Causes Resulting in Lock-out/Tag-out Related Injuries

Employees by-passing or defeating safety switches

Inadequate or ineffective employee training

Lack of a written energy control program or procedures

Mechanical failure or accidental start-up of moving or energized equipment

Lack of communications regarding how to perform lock-out/tag-out

Lack of effective feedback regarding performing lock-out/tag-out

In reviewing the injuries and close calls that occurred at the XYZ Company (Figures 1 and 2), many of the same basic causes listed in Figure 19 were identified on the incident reports as direct or contributory in these cases. The frequency or severity of the incidents did not directly correlate with any one factor. Rather, it was a combination of several of the basic causes that contributed to the events. In addition to the injuries and losses, regulatory action in the form of an OSHA inspection could also occur, with subsequent citations and fines. There could also be other indirect losses, such as re-directed resources, increased capital, and negative publicity.

There also appeared to be a direct correlation between the scores and negative performance from the Production 3 Department and the fact that five of the seven injuries or close calls reported in this study occurred to employees from that department (Figure 2).

Conclusion

The ability for the XYZ Company to prevent future, particularly catastrophic injuries, will depend on following the recommendations discussed in Chapter Two. Continuing with a 'business as usual' approach, where instruction on energy control is unclear or procedures are vague, will at best leave the absence of injuries or losses to chance. Operating an effective manufacturing facility will require the XYZ Company to establish and maintain sound, well-designed and well-communicated energy control and machine guarding programs. The recommendations gleaned from the research conducted in Chapter Two highlight preventive efforts and safe practices.

The application of the six instruments introduced in Chapter Three and evaluated in Chapter Four appeared to produce improvements in terms of employee performance and loss control. Indeed, through the duration of the study, once the audits and evaluative tools were initiated, there was only one lock-out/tag-out related incident reported. (One incident was reported in January 2002, prior to the onset of the study.

The other incident was reported in April 2002). It is critical that XYZ Company management continues the implementation of the instruments applied in this study, coupled with well-defined energy and machine guarding safety programs. Doing so will help build a culture supportive of correct and safe practices. This will lead to an overall safe working environment where the risk of employee exposure to moving or unguarded machinery is minimized and effective, operational efficiencies are realized.

Recommendations

One recommendation following this study would be for the XYZ Company to continue to apply the instruments described and receive 'safe' results or responses from each and all of the audits and surveys performed. Focus should be placed on the Production departments, particularly Production 3. It is suggested that continually reinforcing expected behaviors would result in 'safe' observations and positive scores on future surveys. The recommendation then, (and test of the hypothesis) would be to determine if exposure and contact with moving or energized equipment could be prevented when and if positive scores are achieved and maintained.

Regarding the Lock-out/tag-out Audits, the application of best practices would relate to positive replies from the questions listed in Section I. Higher scores would indicate greater compliance with lock-out/tag-out regulations. The combination of receiving affirmative scores in Section I (200 points), along with no positive replies in Section II (0 points) would lead toward the attainment of best practices for working around industrial equipment. The ability of the company to continue to increase department and overall facility audit scores would lead to controls and processes designed to prevent further losses or exposures to injuries and accidents relating to lock-out/tag-out.

While it is important to develop new JSA's, it is equally important to update and revise existing ones. This is especially relevant should an injury occur. In the event of a

lock-out/tag-out related injury, part of the incident analysis would include a review of the JSA. If the safe procedures were followed and the injury still occurred, then there is a flaw in the JSA and it must be re-evaluated and changed to reflect the safe procedures.

Other means for following established safe practices and procedures could also be applied. This could include providing disciplinary action, such as issuing a warning or suspension to the employee observed performing the unsafe act. However, the behavioral audits were designed to provide corrective feedback. Unsafe behaviors observed under other conditions (such as a routine walk-through) could be addressed through disciplinary or other actions.

The recommendations described in Chapter Two developed out of the accident analyses that occurred. Many of the accidents were tragic or life-altering. The XYZ Company experienced serious lock-out/tag-out related accidents in 1994 and 1995. The incidents reported in 2001 and 2002 could have been equally as devastating. Implementing an effective energy control plan requires commitment and ownership by management and employees alike.

The next steps involve continuing to apply the instruments and improve the company's lock-out/tag-out and machine guarding programs. The elements described in Figures 20 and 21 outline recommendations for implementing an effective energy control process.

Figure 20: Primary Steps for Establishing an Effective Energy Control Process

Develop a comprehensive written lock-out/tag-out plan

Develop lock-out/tag-out procedures for all equipment

Identify all jobs and tasks that require lock-out/tag-out (JSA's)

Provide practical employee training on lock-out/tag-out and machine guarding

Certify employees authorized to conduct lock-out/tag-out

Apply engineering and administrative controls when possible to reduce exposure

Issue each authorized employee individual locks and tags

Figure 21: Secondary Steps for Maintaining an Effective Energy Control Process

Illustrate and post the sequence of lock-out/tag-out steps on identified equipment

Conduct periodic audits to ensure compliance with established procedures

Conduct behavioral audits and provide employee feedback

Provide consistent practices and procedures throughout the company

Allow no deviation from the written procedures.

Provide corrective discipline when unsafe acts or conditions are observed

Perform preventive maintenance to keep equipment at peak operational efficiency

These elements comprise a combination of points emphasized in Chapter Two, along with research performed and collected from the instruments applied in this study. Together, a comprehensive set of objectives and tactics will help promote an effective system of energy control and machine guarding.

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LIST OF ATTACHMENTS

A General Working Environment Survey

Date:	Area or Department Observed
Person Performing the Checklist	

Instructions: Write in whether the observation is safe, at risk or n/a

1.0 People

1.1	Work pace (Are employees working in a hasty manner?)
1.2	Lifting Procedures (Are employees moving materials safely?)
1.3	Using Crossovers Properly (Are employees using crossovers?)
1.4	Awareness of Surroundings (Are employees aware of what is happening around them?)
1.5	Attention to Work (Are employees paying attention to work tasks?)

2.0 Work Environment

2.1	General Housekeeping (Does the facility have an overall good appearance?)
2.2	Aisle/Floors Clean (Is there a clear path of egress?)
2.3	Floor Surfaces Clean (Is there oil or debris on the floor?)
2.4	Trips/Slips/Falls Potential (Are there items in areas that may cause a potential hazard?)
2.5	Daily/Monthly Inspections Complete (Are all scheduled inspections completed on time?)

3.0 Personal Protective Equipment (PPE)

3.1	Hearing Protection (Is everyone wearing hearing protection?)
3.2	PPE (Is PPE available where required or needed?)
3.3	Eye/Face Protection (Are goggles and safety glasses worn when needed?)
3.4	Hazard Communication Labeling (Do all containers have correct labeling?)
3.5	Machine Guarding in Place (Are all guards in place?) (Are safety switches and doors in proper working order?)

A General Working Environment Survey

Safe At Risk N/A

4.0 Communications

4.1	Barriers/Guards Used (Are potential hazardous areas protected with signs or barriers?)
4.2	Forklift Horns/People Awareness (Do operators use horns and stop at intersections?)
4.3	Lock-out/Tag-out (Are lock-out/tag-out procedures being used and audited?)
4.4	Exits and Access (Are all required signs in place?)
4.5	Hazardous Materials (Are MSDS's accessible?)

5.0 General Safety

5.1	Safety Audits (Are self-audits being completed in a timely manner?)
5.2	Fire Extinguishers (Are extinguishers in plain site and accessible?)
5.3	Electrical (Is there a 3' clearance on all side of electrical panels?)
5.4	Monthly Safety Training (Is monthly training being done?)
5.5	Supervisor/Employees (Have supervisors trained new employees on safe practices?)

Total Actions: # of Safe _____ # of At Risk _____ # of N/A's _____

_____ % Safe Actions = # Safe divided by (#Safe + # At Risk)

Comments:

Overall Facility Rating Score: Section 15:
The Control of Hazardous Energy (1910.147)

15.1 Does this department or plant have a written program consisting of energy control procedures and has employee training been established?

_____ Yes _____ No

15.2 Does this department or plant conduct annual lock-out/tag-out training and is there documentation to verify this training?

_____ Yes _____ No

15.3 In this s department or plant, has every employee required to participate in the lock-out/tag-out program been issued a lock and tag, that is individually keyed, and does an inventory program exist for this equipment?

_____ Yes _____ No

15.4 In this department or plant, is there a written procedure for lock removal and does it demand verification of two participants

_____ Yes _____ No

15.5 In this department or plant, is there written documentation to verify that audits are being performed to prove that employees required to lock-out/tag-out equipment are complying with the Control of Hazardous Energy Standard?

_____ Yes _____ No

15. 6 Are lock-out/tag-out devices being used in this department or plant for other sources of energy such as electrical, mechanical, hydraulic, pneumatic, chemical, thermal sources?

_____ Yes _____ No

15.7 Is the direct energy source being locked out/tagged out in this department or plant instead of control circuit devices?

_____ Yes _____ No

Subtotal _____ Yes _____ No

Lock-out/Tag-out (LOTO) Audit

Facility and/or Department
Date Conducted
Person Performing the Audit

Section I: Compliance. Answer each question with a 'Yes' or 'No'
Points awarded: 5 points for a 'yes' answer, 0 points for a 'no' reply.

Review of the Plan

	Reply	**Points**
Is there a written LOTO plan?		
Is the LOTO plan customized or specific to the department or plant?		

Reviewing Training and Certification: Within the last 12 months:

Have all affected employees received awareness training?		
Have all authorized employees received practical training?		
Have contractors received training on applicable conditions and equipment?		
Have all authorized employees been certified on their assigned equipment?		
Have LOTO certifications been performed on each piece of equipment capable of being locked out?		

Employee Monitoring

Are behavioral audits conducted measuring employee performance with LOTO?		
Do contractors comply with plant and company LOTO standards?		
Has disciplinary action been taken against employees who have violated safe practices or safe procedures involving LOTO?		

Locks and Tags

Are authorized employees issued their own locks, individually keyed?		
Are the locks used for LOTO consistent throughout the department or plant?		
Are LOTO locks different from locks used for other purposes?		
Do employees know where to obtain the devices used for LOTO? (Ask)		
Do the LOTO locks and tags display the employee's name and current date?		
Are locks and tags used for LOTO distinct and easily identifiable?		
Are the locks and tags durable to withstand repeated usage?		

Labeling

Has all energy-isolating equipment been located and identified?		
Are specific LOTO procedures listed on each piece of applicable equipment?		

Equipment

Can all equipment be locked and tagged out at the primary power source?
Are the points for applying locks and tags visible and readily accessible?
Are production or cycle stops easily identifiable?
Are emergency stops easily identifiable?

Subtotal 'yes' answers and points

_____ _____

(23 questions, a possible 115 points)

Safe Practices and Procedures

	Reply	**Points**
Have JSA's been completed for all tasks associated with LOTO? (If not, indicate % complete and target expected for full-mapping):		
Do employees follow specific procedures for securing machinery and equipment?		
Do authorized employees verify zero energy prior to working on the equipment?		
Is good housekeeping maintained in and around the area?		
Is the area cleaned up and readied prior to removing LOTO devices?		
Are all sources of energy prevented from accidental start-up?		
Do authorized employees test for and relieve stored energy prior to working on the equipment?		

Application

Are the employees performing LOTO authorized to do so?
Are affected employees notified when LOTO takes place?
Are locks and tags used for isolating energy and securing equipment?
Are the LOTO devices placed on the primary energy source?
Are energy control practices in-place to prevent against accidental start-up?
Are other protective devices or practices observed (such as line breaking, or placing a block against potentially moving parts)?
Are group locks and hasps utilized where multiple employees are required to work on equipment?

Starting Back Up

Are affected employees in safe positions, away from potential energy sources
Did authorized employees remove their own LOTO devices
Before restarting machinery, is there clear communication warning all authorized and affected employees?

Subtotal 'yes' answers and points

_____ _____

(17 questions, a possible 85 points)

Total 'yes' answers and points, pages 1 & 2

(40 questions, a possible 200 total points)

_____ _____

Section II. Deficiencies. Answer each question with a 'yes' or 'no'
Points indicated: 25 points for each 'yes' answer.

Note: *** *For any deficiencies, a corrective action plan is required* **Reply** **Points**

Is there evidence of overriding – defeating energy controls, such as magnets or tape?
Under LOTO conditions, do unauthorized employees enter or operate equipment?
Are employees unclear of whether or not to apply LOTO? (Ask)
Is the covering of cycle or emergency stops considered as LOTO?
Do employees clear jams without applying any energy controls?
During the process of clearing jams, could equipment accidentally energize?
Is there evidence of incidents or close calls involving LOTO violations?
Do employees open interlock doors or activate emergency stops, without locking out energy, under LOTO situations?

Subtotal 'yes' answers and penalty points (8 questions, 200 possible points)

_____ _____

Deduct penalty points on Section II, from points awarded on Section I.

Job Safety Analysis

Department	*Job or Operation*	*Person Assigned*

Required and/or Recommended Personal Protection Equipment

Basic Job Steps	*Potential Hazard*	*Recommend Safe Job Procedure*

Analysis by:	*Analysis approved by:*	*Date Conducted*
Date Revised		

Safety Check

Department or Area: _____ Reference JSA _____

Date _____ Time and/or Shift _____

Performed by: _____ Person observed (if applicable) _____

Safe Procedures	Yes	No	n/a	Commnets
1.	____	____	____	
2.	____	____	____	
3.	____	____	____	
4.	____	____	____	
5.	____	____	____	
Corrective actions or comments:				

Employee Lockout/Tag-out (LOTO) Certification

Employee name _____ Employee number _____

Department _____ Job Title _____

Equipment name _____ Equipment No. _____

Check the box when the correct action is demonstrated. The employee:

Action		Skill or Knowledge Displayed
1. Obtains a lock	☐	… look for assigned lock or correct LOTO lock or device
2. Obtains a tag	☐	… employee signs and dates the tag
3. Locates the disconnect	☐	… primary energy source is identified
4. Notifies affected persons	☐	… communicates that equipment will be out of service
5. Conducts normal shutdown	☐	… turns away from source when switching power off
6. Isolates the energy sources	☐	… identifies the control point(s)
7. Applies the lock	☐	… tests lock to ensure that it's securely fastened
8. Applies the tag	☐	… tag is clearly marked and visible
9. Eliminates stored energy	☐	… releases stored energy
10. Tests equipment for operation	☐	… verifies zero energy state
11. Removes the lock and tag	☐	… inspects area to see that it is free of hazards
12. Prepares for start-up	☐	… communicates with others nearby prior to start-up
13. Re-energizes the equipment	☐	… turns away from source when re-starting power
14. Returns lock and tag	☐	… to the designated location

15. Completion of proper paperwork (describe as applicable below):

Check One Box: The employee completed LOTO certification on the specified equipment:

☐ Yes ☐ No

(If certification is not granted, describe the deficiencies and appropriate corrective action steps to be taken (indicate on reverse side, tasks, persons responsible, and target dates)

Employee Signature _____ Date _____

Signature of Evaluator _____ Date _____