Safety Science 84 (2016) 117–130

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/ssci

Managing risks linked to machinery in sawmills by controlling hazardous energies: Theory and practice in eight sawmills

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ARTICLE INFO

Article history:
Received 12 June 2015
Received in revised form 3 November 2015
Accepted 14 December 2015
Available online 29 December 2015

Keywords:
Lockout/tagout
Maintenance
CSA Z460
Machine
Procedure

ABSTRACT

Machines pose various types of hazards and exposure to these hazards can result in injury or death. Risks linked to machinery can be managed by controlling hazardous energies. Safety procedures are thus used to control hazardous energies on machinery when workers perform different tasks such as maintenance, unjamming, or repair work. These procedures are part of a safety management policy for hazardous energies. The policy is described in a document referred to as the lockout program, which includes activities and work targeted by lockout, audits, hazard identification, training, communication and so on. The objective of this paper is to understand how the lockout program is actually implemented. As such, seven lockout programs from eight sawmills were analyzed. Twenty-two interviews were conducted with machine operators, maintenance workers and managers to gain a better understanding of the actual application of lockout programs, identify weak points and propose improvements. Fifty-seven lockout procedures were also observed. It was found that (i) hazard identification was incomplete, (ii) lockout program signatures and dates were missing, (iii) actual lockout practices were better than the procedures described in the programs regarding lockout hardware, rules to observe when using lockout hardware (e.g. keeping keys in one's possession at all times) and machinery design for facilitating lockout, (iv) locks were applied to control systems during minor unjamming contrary to lockout principles, and (v) permits were issued as alternatives to lockout for troubleshooting without risk assessment. In actual fact, risk assessment is needed for both interventions requiring lockout and those without lockout.

1. Introduction

Machines pose various types of hazards, and exposure to these hazards can result in injury or death. Different types of machinery hazards are listed in ISO 12100, CSA Z432, ANSI B11-TR3, and Bluff (2014). They may be structural (e.g. sharp edges, projections), mechanical (e.g. entanglement, crushing, cutting), physical (e.g. electricity, pressurized content, noise and vibration, hot or cold temperatures), ergonomic (awkward working positions, manual handling, repetitive movements), slips/trips/falls (e.g. poor walkways, railings), chemical (e.g. gases, fumes, liquids), end-use conditions (e.g. location, impact on workplace layout) and biological (e.g. bacteria, mold) (Bluff, 2014). Since workers intervene on machinery in all phases of its life cycle (i.e. installation, operation, maintenance, troubleshooting, repairs, adjustments, set-up, production disruptions, cleaning and dismantling), they are exposed to hazards. Many accidents involve machinery, with sawmills accounting for a large number of them in Quebec, Canada (Chinniah, 2015).

Sawmills are dangerous workplaces since they have many hazardous machines such as chain conveyors, circular saws, vertical saws, hydraulic equipment, mobile machinery and edgers. According to Quebec's worker compensation board (CSST, 2012), sawmills pose a high degree of occupational risk. Accidents that involve workers being caught or crushed account for 18.8% of the accidents reported in sawmills; those involving being hit by an object account for 10.7%. Table 1 provides an overview of 10 accidents for which data were rapidly extracted from the CSST database to illustrate these types of accidents.

1.1. Introduction to lockout

National standards such as CSA Z460:13 in Canada and ANSI/ASSE Z244.1:03 (R2014) in the United States describe requirements related to the control of hazardous energies associated with machinery. They define lockout as the placement of a lockout device on an energy-isolating device, as shown in Fig. 1, in accordance with an established procedure. Lockout is therefore a step-by-step procedure followed by an authorized employee (one who is trained in lockout) in order to prevent injury from unexpected (inadvertent) machine start-up or energization, or the

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http://dx.doi.org/10.1016/j.ssci.2015.12.010
0925-7535/

Table 1
Overview of 10 sawmill accidents in Quebec.

Machinery involved	Day or night	Injury	Hazard	Activity at time of accident	Position held by worker involved in fatal or serious accident
Motorized rollers at the end of saws	D	Death due to crushing	Downward movement of rollers	Sharpening blades	Sharpener, mechanic
Edger	D	Both legs amputated	Rotation of saw blades	Sharpening blades	Sharpener, mechanic
Conveyor	N	Death due to leg being pulled apart	Moving chain	Unjamming	Debarker operator
Conveyor	D	Death	Nip point between belt and conveyor	Cleaning	Cleaner
Edger	D	Death due to injury to thorax	Wood projected onto operator	Unjamming	Operator
Sorting table	D	Death due to wood hitting the head	Timber falling on worker	Unjamming	Stacker
Stacker	D	Death due to crushing injuries	Movement of fork used for lifting onto stacker	Unjamming	Mechanic
Conveyor	N	Death	Nip point between belt and conveyor	Cleaning	Helper
Vertical saw	N	Death due to cuts to abdomen, right hand and arm	Moving blades	Unjamming	Operator
Hydraulic arm on conveyor	D	Death	Arm moved and trapped against fixed structure	Unjamming	Debarker operator

Fig. 1. Application of a padlock during a lockout procedure.

release of stored energy. The main steps in a general lockout procedure are (i) preparation for shutdown; (ii) machine, equipment or process shutdown, (iii) machine, equipment or process isolation, (iv) application of lockout devices, as illustrated in Fig. 1, (v) controlling stored energy (de-energization) and (vi) verification of isolation (performing start-up test or using measurement instruments). Machines pose different types of hazards, including mechanical, electrical, thermal, and chemical, among others. Lockout should therefore protect personnel from injury caused by the inadvertent release of hazardous energy on machines. The release of hazardous energy includes unintended motion of mechanical parts, energization, start-up or release of stored energy. The lockout program ensures that the procedures are applied correctly by all workers, on every piece of equipment and for each intervention. Fig. 2 shows the main components of a lockout program. It consists of elements such as general information, roles and responsibilities, review of the program, training, communication, hazardous energy sources, equipment design characteristics, lockout hardware and their use, activities, general lockout procedure, lockout of equipment in the immediate surroundings, general return-to-service procedure, general lockout placards, continuity of lockout (change in work shift or repairs not completed), the absence of the authorized individual, and external services or subcontracting (CSA Z460; ANSI/ASSE Z244; Burlet-Vienney et al., 2010; Chinniah et al., 2008; Chinniah, 2010; Kelly, 2001).

1.2. Accidents linked to absence of or incorrect lockout procedures

In the United States, lockout is described by the Occupational Safety and Health Administration (OSHA) in standard 1910.147. Also in the U.S., around three million workers performing servicing and maintenance tasks would risk serious injury if lockout procedures were not properly applied (U.S. Department of Labor, 2005). OSHA reported 4149 violations of its regulation on the application of lockout procedures for the year 2000 out of a total of 17,478 after-complaints inspections and 41,932 planned inspections (OSHA, 2004). In 2005, lockout was the fifth most cited category of causes of incidents in OSHA reports, and 90% of these citations were due to lack of lockout procedures. Five hundred ninety-two lockout/tagout-related incidents in the U.S. resulting in a total of 624 fatalities were reviewed (Bulzacchelli et al., 2008). In the majority of cases (70%), lockout procedures were not attempted at all. There were very few incidents in which a lockout attempt was made and a fatality occurred due to human error (5.2%) or mechanical failure (1.2%). This small proportion suggests that lockout/tagout procedures, when properly followed, do indeed prevent fatalities. Several strategies for increasing the use of lockout/tagout are proposed. The author recommends further research on understanding barriers to following lockout/tagout procedures and on finding ways to increase usage of these procedures. Shaw (2010) reviewed 100 incident investigation reports in the United Kingdom spanning the period 2002–2007 and identified a number of contributory causes. The review revealed that failures to isolate (lockout) were major contributors. Blaise and Welitz (2010) retrieved, from the French EPICEA database, 88 accidents occurring between 1998 and 2007 and involving machinery during non-production phases (i.e. maintenance). Their study reports that operators also perform maintenance actions. The distribution of non-production-phase machinery accidents by risk factor included organizational aspects (69%) corresponding mainly to compliance with procedures, in particular, isolation/lockout. Lind (2008) analyzed 33 Finnish accident reports of fatal and severe non-fatal accidents involving industrial maintenance. The author found that organizational factors and unsafe actions were the main causes of the accidents and recommended safe working methods (lockout). Chinniah (2015) reported that in the case of 33 accidents out of a total of 106 accidents linked to moving parts of machinery in Quebec, Canada, the companies involved did not have a lockout program and lockout procedures were not used during maintenance, repairs and unjamming activities, as required by Quebec's OHS regulation, the Regulation respecting Occupational