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Qualitative study on the control of hazardous energy on machinery using lockout and alternative methods

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ABSTRACT

In Canada, like many countries, the national standard and provincial regulations require that workers performing maintenance, repair, and un-jamming activities on machinery must follow lockout procedures. However, the high number of accidents linked to hazardous energies and machinery shows that organizations have difficulty with the application of lockout arrangements or use of alternative methods. Therefore, it is important to understand how organizations implement lockout programs and procedures, and the extent to which they are in accordance with relevant standards and regulations. In this qualitative research, the application of lockout and alternative methods was studied in 13 organizations in Quebec, through a group interview, document review and site observation in each organization. In each organiztion, the researchers conducted a group interview and completed a questionnaire, which included more than a hundred questions on the lockout program, application of lockout procedures, alternative methods, sub-contractor management, training, and audit/inspection. The researchers then used observation data and documentation collected from each organization to verify interviewee responses and to finalize the questionnaire. The shortcomings found included: (i) incomplete lockout programs; (ii) missing steps in general lockout procedures; (iii) not reading the placards; (iv) using alternative methods without risk assessment; (v) poor training for alternative methods; (vi) absence of supervision and coordination of subcontractors; (vii) and lack of audit tools and documentation of audit results. Despite the shortcomings, actual lockout practices in the organizations visited were better than what was described in their lockout programs. Recommendations for addressing identified shortcomings are proposed.

1. Introduction

Workers intervene in all phases of a machine life cycle (i.e. installation, operation, maintenance, troubleshooting, repairs, adjustments, set-up, production disruptions, cleaning, and dismantling) and consequently their exposure to different types of machinery hazards and hazardous energies can result in injury or death (Chinniah, 2015; Yamin et al., 2016). Various types of machinery hazards are listed in standards such as International Organization for Standardization [ISO] (ISO 12100, 2010), Canadian Standards Association [CSA] (CSA Z460, 2013), American National Standards Institute [ANSI] (ANSI B11-TR3, 2000), and in the scientific literature (e.g. Chinniah et al., 2007; Bluff, 2014).

Regulations such as Occupational Safety and Health Administration [OSHA] (OSHA 29 CFR 1910.147, 1989) in the U.S., and Quebec's Regulation Respecting Occupational Health and Safety (ROHS, 2017) address the minimum requirements necessary for the methods which are applied during the non-production phase (i.e. service, repair, and maintenance) of machinery and equipment to control hazardous energies (e.g. electrical, hydraulic, pneumatic, kinetic, potential, chemical, and thermal in nature). In addition to regulations, the international standard ISO 14118 (2000) and North American standards such as CSA Z460 (2013) in Canada and ANSI/ASSE Z244.1 (2016) in the US describe the requirements for, and provide guidance on, the control of hazardous energies which is also referred to as lockout/tagout. These standards also advise on alternative methods to lockout.

In Quebec, regulations on lockout were strengthened in 2016 as shown in Table 1. Obligations are now in line with North American standards and OSHA 29 CFR 1910.147 (1989). Previously, lockout was mentioned in the regulation without any explanation of what to do. However, in Canada, CSA Z460 was published in 2005 and the control of hazardous energy has been in practice in some organizations in Quebec for some time.

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Table 1
The most important updates in Quebec's regulation in terms of the control of hazardous energies (ROHS, 2017).

Regulatory changes (Article 188.1-13: 2017)	Content
1	Develop a lockout procedure (lockout placard) for each machine or equipment
2	Identify the machine, the energy sources, the lockout material and the steps required to control the energy
3	Train workers on lockout and verify their competencies
4	Manage subcontractors, i.e. the employer's responsibility for supervising the work assigned to another employer or a self-employed worker
5	Describe the type of lock to be used
6	Use of a specific procedure in case a lock is forgotten on a machine or a key is lost
7	Use of alternative methods through a risk assessment when lockout cannot be applied

1.1. Lockout program and procedure

A lockout program is the document that establishes the company's general policies and procedures for implementing lockout. It also provides the instruction for regulatory compliance. Lockout programs should contain the following elements: (i) identification of the hazardous energy covered by the program, (ii) identification of the types of energy isolating devices, (iii) identification of the types of de-energizing devices, (iv) selection and providing of protective materials and hardware, (v) assignment of roles and responsibilities, (vi) determination of shutdown, de-energization, energization and start-up sequences; (vii) examples of written lockout procedures for machines, equipment, and processes, (viii) training of employees, and (ix) auditing of program elements (Burlet-Vienney et al., 2009; Chinniah, 2010; ANSI/ASSE Z244.1, 2016; CSA Z460, 2013; Poisson and Chinniah, 2015).

The lockout procedure provides a step-by-step approach that the authorized employee (one who is trained on lockout) must follow in order to prevent injury from the unexpected (inadvertent) start-up, energization or release of stored energy. The general lockout procedure requires: (i) preparation for shutdown, (ii) machine, equipment or process shutdown, (iii) machine, equipment or process isolation, (iv) application of lockout devices, (v) dissipating and controlling stored energy (de-energization), (vi) verification of isolation (start-up test or using measuring instruments) (Chinniah and Burlet-Vienney, 2013; CSA Z460, 2013; Poisson and Chinniah, 2016; ROHS, 2017). The lockout procedure (and return to service) for a machine, equipment or process needs to be readily accessible to authorized employees and described in a placard with all necessary information.

1.2. Alternative methods to lockout

According to OSHA 29 CFR 1910.147 (1989) and CSA Z460 (2013), traditional lockout to a full zero energy state is not practicable in all situations. When lockout affects the tasks that are integral to the production process by design, or traditional lockout prohibits the completion of specific tasks, other hazardous energy control methods can be used. According to the Canadian standard, the tasks considered integral to production exhibit most of the following characteristics: (i) of short duration, (ii) relatively minor in nature, (iii) occurring frequently during the shift or production day, (iv) usually performed by operators, set-up persons, and maintenance personnel, (v) represent predetermined cyclical activities, (vi) minimally interrupt the operation of the production process, (vii) exist even when optimal operating levels are achieved, and (viii) require task-specific personnel training (CSA Z460, 2013).

Before adopting other methods of control, the user should conduct a risk assessment that demonstrates the effectiveness of the protective measures. The standards such as ISO 12100 (2010), CSA Z460 (2013) and ANSI/ASSE Z244.1 (2016) provide guidance on conducting risk assessments and list alternative methods.

1.3. Accidents related to the absence of, or improper lockout program and procedures

In spite of various lockout-related standards and regulations, accidents caused by the absence of lockout or inadequate lockout procedures still happen. In the U.S., OSHA inspectors' reports show that companies were given citations for the improper lockout because of (i) lack of training and communication in lockout procedures, (ii) absence of lockout procedures and (iii) lack of audit and periodic inspections of lockout procedures (OSHA, 2015).

Recent studies analyzing accidents involving machines during the non-production phase such as in US (Bulzacchelli et al., 2008; Martin and Black, 2015; Ruff et al., 2011), Canada (Chinniah, 2015), UK (Shaw, 2010), France (Blaise and Welitz, 2010), and Netherlands (Aneziris et al., 2013) reveal that the absence of or deficient lockout procedures is one of the main causes of serious and fatal accidents.

The US Bureau of Labor Statistics (BLS, 2016) revealed that in 2015, a total of 722 fatal work injuries (15%) occurred as a result of contact with objects and equipment. Moreover, OSHA reported that lockout was the fifth most cited OSHA violation in 2015 and 2016. In those two years, OSHA issued respectively 3585 and 3308 citations for alleged violations of the lockout/tagout standard (OSHA, 2016, 2015).

In Canada, in 2013, 17% of orders issued by the Ontario Ministry of Labor to employers were because of lockout and machine guarding violations (Ontario Ministry of Labor, 2016). Moreover, in 2015, Quebec's workers' compensation board reported that on average, 10% of fatalities in that province occurred annually due to poor or absent lockout procedures (Commission des normes, de l'équité, de la santé et de la sécurité du travail CNESS,T 2016).

1.4. Gaps and shortcomings associated with lockout/tagout reported in the literature

Chinniah (2015) identified the main cause of fatal and serious injuries involving fixed machinery from 106 accident reports in Quebec. This study reported that 54 accidents (51%) were linked to the absence of or poor lockout. In fact, lockout procedures were not used during maintenance, repairs and unjamming activities. The study found that having a lockout program does not imply that lockout procedures are being applied.

In another study, 457 incident reports from six multinational organizations in different industries were analyzed (Martin and Black, 2015). Incidents with the potential to cause serious injuries and fatalities were strongly linked to deficiencies in management systems related to lifesaving policies, programs (e.g. lockout, machine guarding and barricades, etc.) and risk assessment. The study indicated that a serious injury or fatality happens during routine operation/production or maintenance/repair tasks when these management systems are either absent, ineffective, or not complied with.

Poisson and Chinniah (2015, 2016) showed the difficulties and gaps of the actual lockout practices in eight sawmills in Quebec. They analyzed the application of 57 lockout procedures and of seven programs. The studies identified shortcomings such as: (i) incomplete hazard