Views on the Current State of Controlling Hazardous Energy

A Survey About the Control of Hazardous Energy

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- NSC *The National Safety Council*
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- PMA *The Precision Metalforming Association*
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Abstract

As manufacturing becomes more complex and automation increases, safety practices must also evolve. For many years, a primary tenet of machinery safety has been "guard it or lockout tagout" (LOTO) – a practice of completely isolating hazardous energy. Often turning off and isolating all the power is the best solution to protect against unexpected startup of equipment. However, with advances in technology and design practices, Alternative Methods are being used throughout industries to provide effective protection. Alternative methods can be thought of as methods where energy is *controlled* as opposed to isolated. In many cases Alternative methods were born of a need within industry to allow specific tasks to be done safely, *without* powering down the entire system.

As U.S. industries, safety practitioners, and OSHA grapple with the many considerations associated with implementing and using Alternative Methods in lieu of LOTO, one common thread continues to be a lack of understanding and information about the use of Alternative Methods.

A survey consisting of 30 questions was conducted specifically to enhance the current state of understanding about the control of hazardous energy including the use of Alternative Methods. The research results and findings are included in this paper, as well as conclusions drawn within the context of practical solutions that yield acceptable risk in the workplace.

There were 276 responses from a variety of industries and company sizes. Highlights of the results include:

- Although there remain some skeptics, the vast majority of respondents are using Alternative Methods as a means to control of hazardous energy.
- A significant majority of respondents agreed that OSHA should consider adopting ANSI Z244.1 and incorporating risk assessment and the hazard control hierarchy to determine the most feasible methods for controlling hazardous energy.
- Both small and large companies are currently able to implement Alternative Methods with the skill set of their current employees.
- Most companies using Alternative Methods have some level of documentation or analysis to support the use.
- The survey results support the tenet that effective risk reduction is rarely just one solution, but typically several, and will often include both Alternative Methods and LOTO.

Based on the results of this survey, the time for debate on the question of whether Alternative Methods should be allowed or disallowed has **past.** As shown in this survey, Alternative Methods are currently included in machinery, equipment and processes, and are already being used throughout industry to keep workers safe from harm.

Contents

Introduction

The control of hazardous energy is common to all industries yet is unique in each application. There are many terms used in discussing the topic, and at times the alphabet soup of acronyms and technical jargon can seem contradictory. Throughout this document, the term "system" is used generically when referring to tasks that require control of hazardous energy. More specifically, tasks may need to be performed on a *machine*, a piece of *equipment*, or a *process* and the control of hazardous energy will apply regardless of the technical differences.

Historically, the control of hazardous energy was first addressed within the private sector – ANSI Z244.1 1982 *Lockout/Tagout of Energy Sources* was written to provide guidance on how to keep people safe using a formal process for "turning off" and "isolating" systems before interacting with them. Members of the original authoring committee have shared that the committee's original intent was never to prohibit the use of new or novel technology. Rather, the standard provided a "how to isolate" process for situations where isolation was the best approach to risk reduction.

OSHA adopted many of the concepts from this original document but deviated from the industry standard in significant ways in creating 29 CFR 1910.147 in 1989. The underlying problem that led to the creation of both the ANSI and OSHA standards is that too many workers suffered fatal and serious injuries when energy was unexpectedly released. In a very simplified view, the OSHA regulations describes two methods for protecting workers when interacting with a system: 1) machine guarding, and 2) lockout. If there is a hazard, OSHA expects that the employer will provide guarding. If a task requires access around the guarding, OSHA expects the employer to isolate the energies and lock the system out. This is a binary approach, and while it made sense in the early 1980s, this simplified approach now creates many issues with modern systems.

Industry quickly determined that "when in doubt, lock it out" worked very well for certain applications and for simple mechanical machines, but caused chaos with many programmable, computer-controlled systems. For example, many processes being monitored by stringent quality systems behave poorly when heat, pressure, or agitation are shut down while a jam is addressed (or other short-term tasks). Functional safety was born in part from the desire to keep people safe without necessarily isolating all the energy sources on a system. Designs that reduce risk using a control system are, in essence, functional safety. Common examples are an interlocked gate that inhibits robot motion when it is opened, or the riding mower seat interlock that stops the ride-on mower when the operator stands up.

Worldwide, the application of machinery safety tends to be based on the risk assessment process. Global safety standards require that risks be identified, and evaluated before appropriate risk reduction measures are applied. In this system, the risks associated with changing a welding tip on a robot might be addressed with the interlocked gate that inhibits robot motions while the tip change is taking place. The inhibit function is performed by a control system that is appropriately reliable for the level of risk encountered, and the task is performed without turning off or isolating the robot power. Other tasks such as changing a servo motor, that are inappropriate under the functional safety method described, would require lockout.

Conversely, OSHA has historically taken a rules-based approach to worker safety. OSHA writes the rules, and employers are expected to meet them. Although this approach works well enough for basic systems, the risk-based approach in industry is a much more effective and functional method.

As early as 1995 Grund called attention to the need for alternative procedures in *Lockout/Tagout-the Process of Controlling Hazardous Energy*. He questioned, "What are the legitimate alternative measures that provide effective protection and minimize the risk, between the polar points - energized/de-energized?"

In *The Battle for the Control of Hazardous Energy*, Main and Grund (2016) describe in great detail the history, legal frameworks, analyses, current situation, and opportunities related to the control of hazardous energy. The book provides the context for the current challenges everyone faces. The authors describe the content as follows:

> A battle is raging over the control of hazardous energy. More specifically, there are competing views on the requirements for how and when to control potentially hazardous energy. On one side is the Occupational Safety and Health Administration (OSHA). On the other side are industries and others that have written a consensus safety standard for the control of potentially hazardous energy (ANSI/ASSP Z244.1).
>
> The current requirements for the control of hazardous energy appear at 29 CFR 1910.147 under OSHA, and in the consensus standard ANSI/ ASSP Z244.1. Unfortunately, there are significant differences between the requirements in these documents that has created confusion as to how and when employers should effectively control hazardous energy to protect employees.
>
> This book reviews the history of the developments related to both the ANSI Z244.1 and OSHA's 29 CFR 1910.147 requirements, as well as the points of conflict that have arisen between the two factions over the years. Although both sides agree on the objective that employees need to be protected from the unexpected startup of machines, equipment or processes, or the unexpected release of hazardous energy, they disagree significantly on how this can be achieved.
>
> The breadth of industries impacted by 29 CFR 1910.147 is enormous. Although the details of safety and global competition differ from industry to industry, the fundamental problems in understanding and applying OSHA's standard are common and have significant impacts across industries. As used in this book "industry" refers to all industries that are impacted by the requirements of 29 CFR 1910.147, even though there are substantial and significant differences between industries such as: metals manufacturing, medical devices, food, pharmaceutical, semiconductors, glass, automotive, packaging, etc.
> …
> There are significant differences between the OSHA requirements in 29 CFR 1910.147 and industry requirements in ANSI Z244.1. The many differences lead to considerable confusion with implications to global competitiveness of U.S. manufacturing.

Since the book was written, the tempest has calmed somewhat. In 2019, OSHA listed a revision of 29 CFR 1910.147 on its regulatory agenda. It sent out a Request for Information in the summer of 2019 and received numerous responses to their questions. The pandemic set back OSHA's revision efforts, but work continued under a lesser priority. At the time of the current survey (fall 2023), OSHA was in Stage 2 of its nine-stage revision process, and working on preparing a revised standard. OSHA has put 1910.147 on its regulatory agenda and a proposed revision could be introduced in 2024. The change will be the first revision since 1910.147 was originally adopted in 1989 (30+ years ago).

Under 29 CFR 1910.147, OSHA usually requires certain tasks to be performed only under LOTO. According to OSHA, machine setup and changeover requires full LOTO, yet on many machines and equipment it is impossible to do this task without power for functions such as thread, inch, jog, etc. Under the industry standard ANSI/ASSP Z244.1, some tasks may be performed using an Alternative Method to control energy rather than locking out as per OSHA. ANSI Z244.1defines an Alternative Method as "A means of controlling hazardous energy (other than energy isolation) to reduce risk to an acceptable level."

The application of functional safety as a safeguarding method is not well contemplated by OSHA's 1910.147. Within the binary nature of the system, one can guard, one can turn a system off completely, but opening an interlocked gate to change a welding tip is problematic. Functional safety, accepted throughout industry worldwide as a safeguarding methodology, now becomes an "Alternative method in lieu of lockout" here in the U.S. This moniker exists solely because 29 CFR 1910.147 creates a strict requirement that does not work in certain situations, and thus requires a different solution or exception to the rule.

ANSI Z244.1(2016) discusses the motivation for using current solutions for the control of hazardous energy:

> In spite of substantial efforts by employers, unions, trade associations and government during the past 50 years, the annual toll of injury and death related to hazardous energy release incidents remains unacceptable. We now know that all forms of energy must be addressed; that operational personnel are injured as often as maintenance workers; that often thermal and gravitational forces and trapped materials under pressure are overlooked; that complex equipment and processes frequently demand unique approaches to energy isolation or control; and that employers need to commit resources and substantial effort in planning, training, procedure development and infrastructure before lockout/tagout application ever occurs.
>
> The rapid growth of technology continues to require different methods and techniques for safeguarding workers from the unexpected release of hazardous energy. Each business sector is actively changing the way traditional work is done, which then requires employers to develop new equally effective responses for hazardous energy control. Protective standards need to be improved continually to provide guidance for current conditions as well as evolving technical developments. Advanced control systems provide new opportunities for addressing energy control where conventional lockout is not feasible, where energy is required to perform a task, where repetitive cycling of an energy-isolating device increases risk, and where energy is required to maintain equipment in a safe state, etc.
> …
>
> There is no disagreement on the basic principle that workers should be protected from the unexpected startup or release of hazardous energy. There continues to be disagreements over how, when and which requirements apply. The committee concentrated on how to control hazardous energy using methods based on current knowledge. The committee discussions focused on what was the right thing to do given current technology and industry best practices to protect workers from harm due to the unexpected release of hazardous energy.

In July 2023, the ANSI Z244.1 committee met to begin the latest revision of the industry standard for the control of hazardous energy. Fortunately, for this revision OSHA is an active member of the committee and is participating in the discussions. The revision of ANSI Z244.1 is expected to be completed in 2024.

Everyone involved in workplace safety has impressions, thoughts, and ideas concerning the root cause(s) of worker injuries and potential solutions to improve workplace safety. Often, conflicting opinions point to differing sources (poor work practices versus poor equipment design) and very different remedies ("being careful" versus better equipment and designs).

Chinniah (2008) studied the regulatory frameworks in many countries and standards for controlling hazardous energy including lockout and using Alternative Methods. The subject survey looks at how the requirements may or may not be applied in industry.

This current survey was undertaken to gather data which OSHA, the ANSI committee, and all involved in the control of hazardous energy can review, evaluate, and apply. This survey collected information about the use of Alternative Methods in lieu of lockout tagout (LOTO) to perform tasks. The study was intended to better understand and inform all parties as to the current status of the workplace as related to the control of hazardous energy.

Methodology / Approach

Purpose

The primary purpose of the survey was to obtain ideas, thoughts, and comments on how to improve the control of hazardous energy and workplace safety. End users must be included in developing solutions to improve workplace safety. They often have an in-depth understanding of tasks required to be performed, the safety challenges and have definitive ideas on potential solutions. The equipment and facility design communities, as well as OSHA, would undoubtedly benefit from understanding the needs, concerns, and influences of the control of hazardous energy on workplace safety. This survey was a channel to reach persons involved with the control of hazardous energy and to collect their ideas on workplace safety.

A second purpose of the survey was to obtain data on the practical constraints and specific needs affecting workers for the control of hazardous energy. These constraints include the context of the current work practices or needs, issues of time pressures, work planning and scheduling, and the level of training. With the resulting data, the discussions and efforts directed to the control of hazardous energy and workplace safety improvements can gain sharper focus.

The control of hazardous energy is only one of many risk reduction methods that will be part of a comprehensive solution to workplace safety. Knowing more about the control of hazardous energy helps in understanding how LOTO and Alternative Methods fit into the overall solution. The survey addresses the control of hazardous energy to better understand the issues impacting its implementation. This survey comprises one step further down the path to reducing risks to an acceptable level.

Method – Population sample

The target population of the survey was personnel involved in the control of hazardous energy for systems. This population broadly included persons who actually perform tasks that require the control of hazardous energy (the workers), as well as their leaders/supervisors and managers who are challenged to develop and maintain a Hazardous Energy Control Program that keeps workers safe from harm. Each of these roles have a perspective on the challenges and possible insights on the underlying causes and potential solutions.

The target audience for the survey included both system suppliers and users.

Survey development

The survey was intended to solicit responses on a range of topics related to the control of hazardous energy and workplace safety. The survey was designed with 30 questions, 3 of which were targeted to suppliers specifically (users did not see these questions). Most of the questions pertained to the primary topic, but a few addressed demographic aspects.

The final survey questions resulted from numerous revisions based on survey research, consultation with knowledgeable experts, and several interim drafts and testing conducted with these drafts. Feedback on the content was obtained from experts and leaders in the control of hazardous energy to greatly improve the survey focus and clarity. Modifications were made to simplify questions, increase the data reliability, and meet the target length. The target length of 8-10 minutes was determined through informal

discussions with representatives of the population, and the need to focus on the most critical concerns. The resulting time constraints limited the number and form of the questions asked.

The data analysis needs to be accessible to the target audience (not black-box science). Therefore, the investigators applied established scientific practices using commonly accepted protocols without implementing overly academic analyses that extend beyond the needs of the intended consuming audience.

The survey was conducted by design safety engineering, inc. with the collaboration of 50+1, a professional surveying organization. The survey was conducted online (only). The presentation of the questions and the potential answers are as shown in the results.

The survey collected no personally identifiable information. As a result, the survey respondents remain anonymous, and the authors have no information as to who participated.

The questionnaire was programmed in Qualtrics. The average length-of-interview was 9 minutes. All grid items were randomized to minimize mode effects. Quality assurance checks were conducted to ensure data quality. In total, 11 interviews were removed for completing the survey in less than one-third of the median interview time or for straight-lining all grid questions asked of them.

Question formatting, wording, and presentation were crafted to achieve clarity in intent, and meaningful answers. A majority of the questions were closed form (as opposed to open-ended). Rating scales were ten points with an additional option of "Don't know" as shown in the results. The point scale included verbal anchors and provided ordinal data.

Deployment

The respondents completed the survey marking their selections and advancing through the survey. In all cases, the responses were anonymous. The questionnaire remained open from 7 September 2023 until 23 October 2023.

Notices of the survey were shared with several industry trade organizations, who in turn shared the survey link with their members. A link to the survey was posted on the authors' website www.designsafe.com. A QR code was also developed and shared at several industry presentations, where participants were able to connect to and complete the survey.

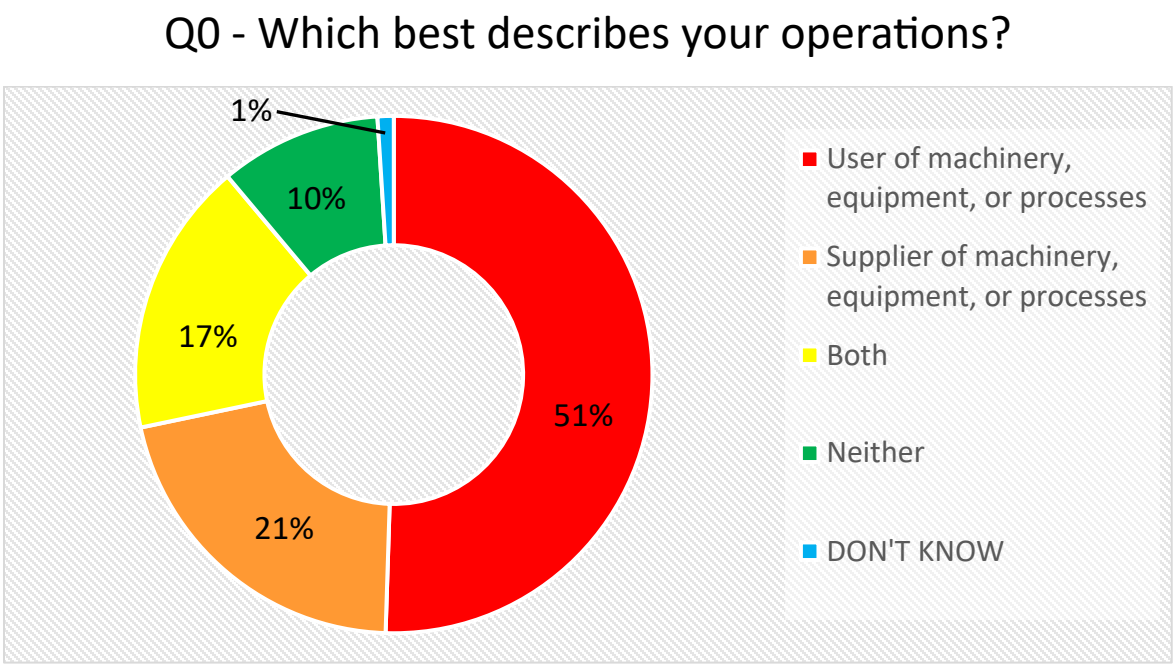
The survey participants self-selected to participate, meaning the topic was of sufficient interest to them to engage, as well as their forwarding the survey link to others who might be interested. The survey cannot be considered a scientific random sample due to the method of deployment. However, the fairly large number of responses and the Central Limit Theorem provide good confidence that the results are representative of the target population.

Results

Survey Responses

A total of 276 responses were completed. The results are shared as follows.

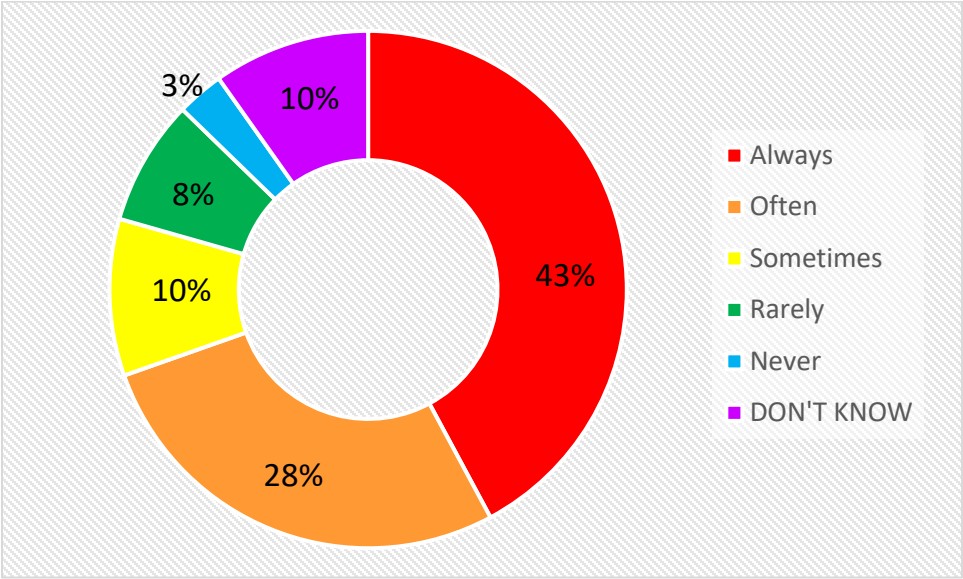
The questions were intentionally constructed to afford respondents some level of plausible deniability. The survey was completely anonymous, and the authors have no information as to who participated. However, given the topics, OSHA's interest, and potential respondent fears of a path to citations, the use of phrasing such as "facilities like yours" was intended to provide respondents the ability to deny any allegation of an OSHA violation by their current employer.



When asked about the description of their operations, most respondents (51%) indicated that they were users of machinery, equipment or processes, while 21% stated that they were suppliers. Combining the Users and Both responses yielded a result of 67% were users of machinery, equipment or processes. This is a significant result as users of these systems must practically address how to control hazardous energy in their operations. That is, their organizations actually use Alternative Methods or LOTO in their workplace(s). The control of hazardous energy is not an academic or theoretical exercise to these respondents, in particular because OSHA places responsibility on the employer.

Supplier Questions

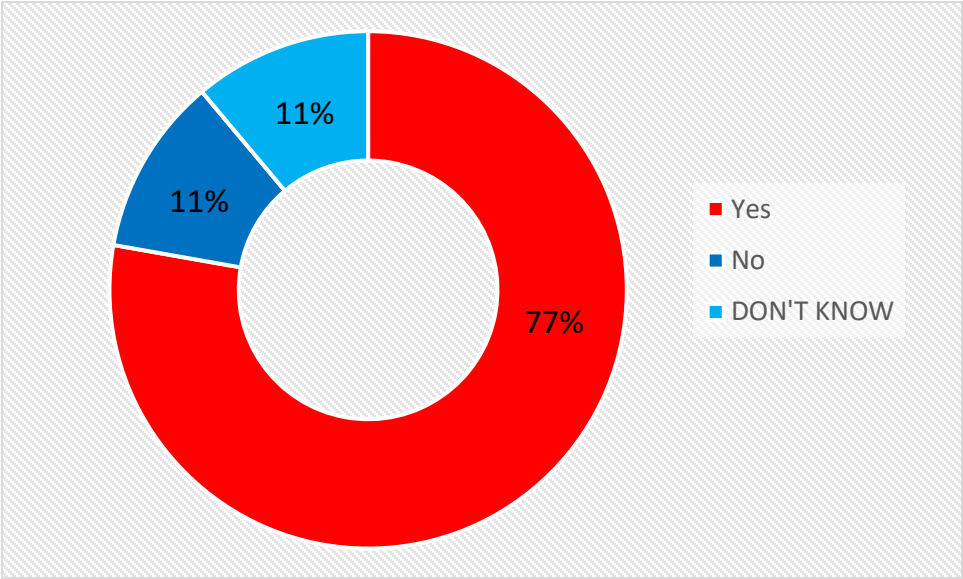
QS1 - As a supplier of machinery, equipment, or processes, how frequently do your designs include safety devices that form part of an Alternative Method to be used for certain tasks?



For respondents who reported being suppliers, 43% indicated that they *Always* include safety devices as part of an Alternative Method, while 28% indicated that they *Often* did. 10% of respondents indicated that they did not know if their designs included safety devices as part of an Alternative Method. The 10% may result from not knowing how the user uses the system, or because the relationship between functional safety systems and Alternative Methods is not well understood. Only 3% indicated *Never*, while combining *Never* and *Rarely* yields only 11%, indicating only 1 in 10 supplier respondents do not offer/include systems intended to be used as an Alternative Method. Combining *Always*, *Often* and *Sometimes* yields 80%, indicating suppliers include safety devices as Alternative Methods in most of the occurrences.

- Few provide systems without Alternative Methods.
- Most currently provide systems with Alternative Methods.
- Alternative Methods are currently being used in industry.

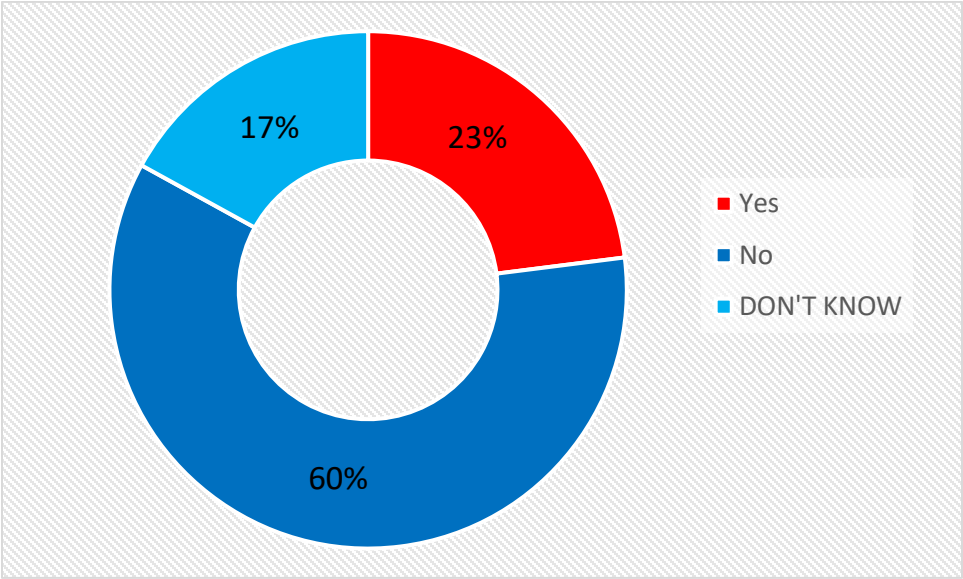
QS2 – As a supplier of machinery, equipment, or processes, do your customers request safety devices that form part of an alternative method be included for certain tasks that OSHA would require locking out the equipment?



77% of suppliers stated that their clients request that safety devices be included as part of an Alternative Method for tasks for which OSHA would require locking out equipment. Three out of four of the suppliers receive such requests. Only 11% indicated this does not occur.

- Users are requesting systems with Alternative Methods even where OSHA requires LOTO.
- Alternative Methods are currently being used in industry.

QS3 – As a supplier of machinery, equipment, or processes, have you had customers request the removal of safety devices that form part of Alternative Method in order to use LOTO in accordance with OSHA requirements?

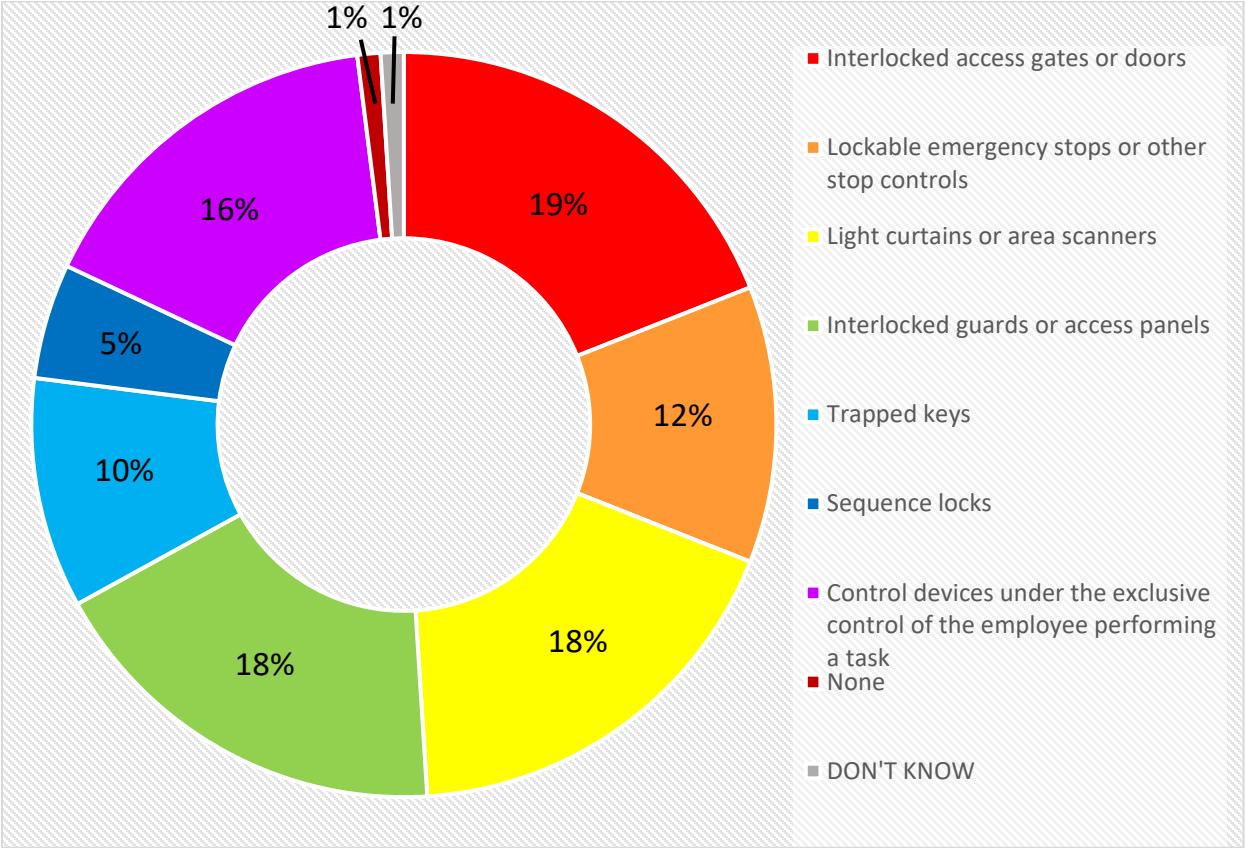


There may be instances where systems provided as part of an Alternative Method may be viewed by the end user as superfluous or even unsafe, and since the user intends to use LOTO, they request the removal of the Alternative Method devices. 60% of providers stated that they have *not* had customers request the removal of safety devices that are part of an Alternative Method. However, 23% or nearly 1 in 4 *have* had such requests. This means that machinery users are requesting the removal of safety systems that take advantage of current technology in order to comply with OSHA requirements and achieve acceptable risks in lieu of full LOTO.

- Some users are asking suppliers to remove safety devices because they intend to comply with OSHA's LOTO requirements.
- Such requests are not unusual (23%).
- The perceived requirements to comply with OSHA result in systems that may have less preferred risk reduction methods.
- The perceived requirements to comply with OSHA result in systems that may have a competitive *disadvantage,* in comparison to the same equipment shipped to other countries.

General Questions

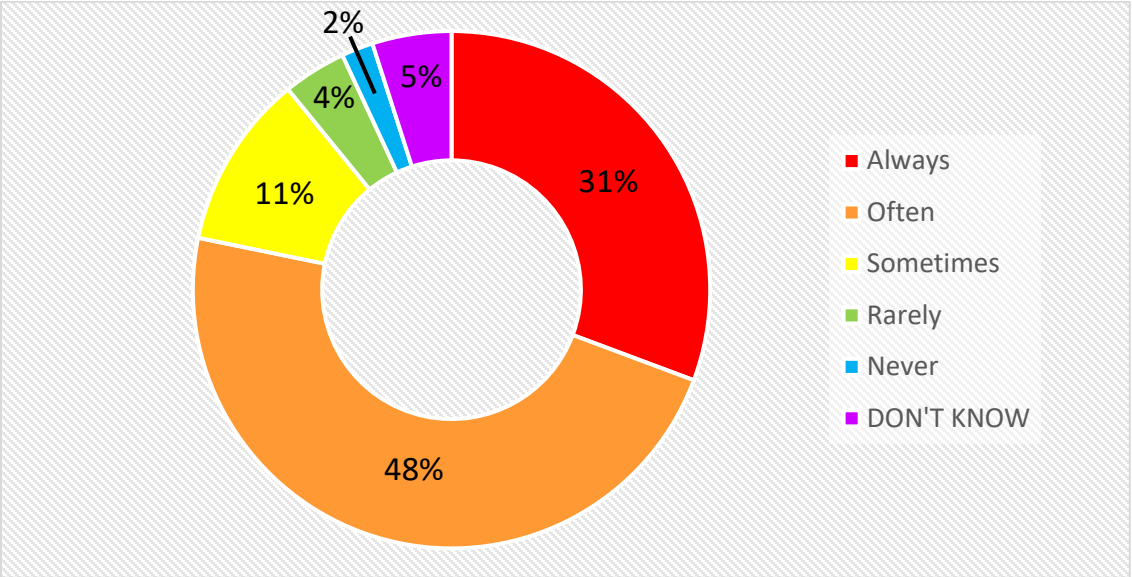
Q1 - To your knowledge, do you use any of the following Alternative Methods in your facility? (Select all that apply)



When asked about the type of Alternative Methods they use in their facilities, 19% of respondents indicated that they use interlocked access doors or gates. In second place were those who use light curtains or area scanners (with 18%), while in third place were those who use interlocked guards or access panels (with 18%).

Responses to this question demonstrate a wide variety of solutions to create Alternative Methods. There is no one technology or solution that is used predominantly. Significantly, less than 1% indicated *None*, which is consistent with the usage responses where 4% indicated no systems use Alternative Methods.

Q2 – How often would you say these Alternative Methods are used in facilities like yours?

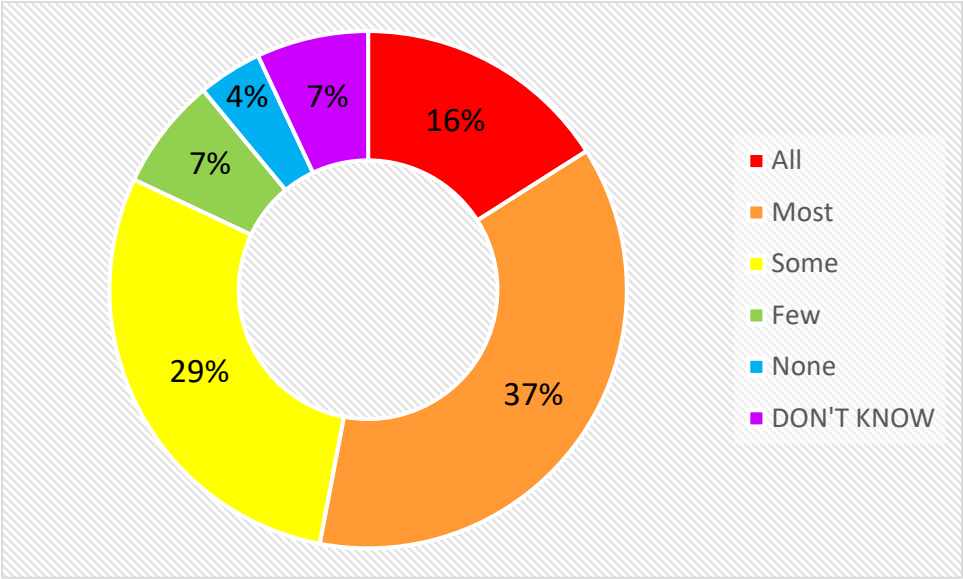


When asked how often the Alternative Methods are used in facilities like theirs, a total of 79% of the respondents stated *Always* or *Often*.

Combining *Always*, *Often* and *Sometimes* yields 90%, while *Rarely* and *Never* yields only 6%. Respondents thus indicated that Alternative Methods are being used today in operations.

- The vast majority of users are applying Alternative Methods, and using them frequently.
- Only a very small portion (6%) are not using Alternative Methods.

Q3 – How many machines/processes/applications in facilities like yours use Alternative Methods?



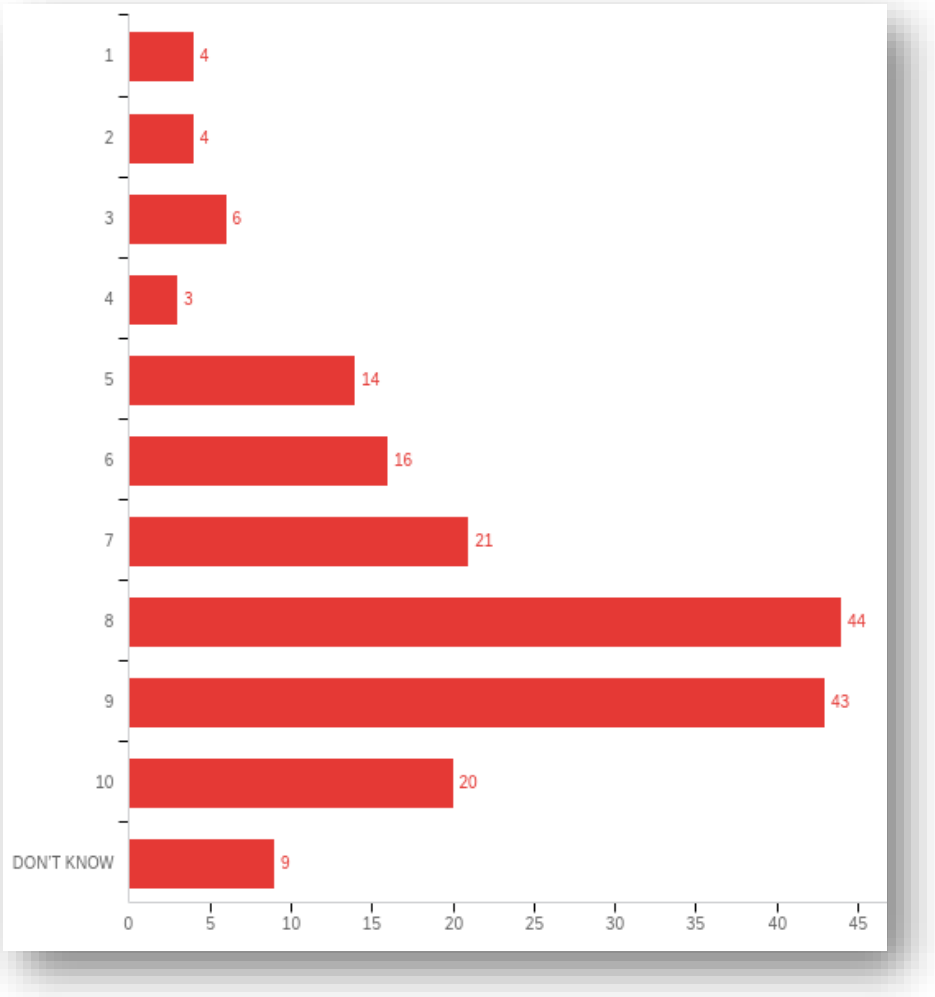
Regarding the number of machines/processes/applications that use Alternative Methods in facilities like the ones from respondents, 53% indicated that *All* or *Most* use them.

Combining *All*, *Most,* and *Some* responses yields 82%, whereas only 11% said that *Few* or *None* do so. This is another indication that Alternative Methods have significant use in industry.

- The vast majority (82%) are using Alternative Methods in their facilities.
- Very few (11%) are not using Alternative Methods frequently in their facilities.

Rating of LOTO reliability

Q4 – OSHA estimates that complying with lockout/tagout procedures prevent around 120 fatalities and 50,000 injuries a year, if done properly. However, these procedures are not always followed, for a variety of reasons. In a scale of 1 to 10, 1 being extremely low and 10 being extremely high, how would you rate the overall reliability of lockout/tagout procedures in your facility?



When asked about the overall reliability of lockout/tagout procedures at their facilities, of the total 184 responses received to the question, 107 ranked between numbers 8 and 10 on the scale. This means that 58% of respondents have high confidence in the reliability in the lockout/tagout procedures in their facility. Only 17 respondents (9%) indicated a very low confidence (rating 4 or lower) in the reliability of lockout/tagout procedures.

The average for this distribution of answers is 7.39, with a standard deviation of 2.15.

Q5 – In your opinion, what are some of the reasons that can make lockout/tagout procedures unreliable in facilities like yours? (Select all that apply)

	Response	Percent	Number
1	Lack of procedures	9%	52
2	Lack of training	10%	62
3	Incorrect use of locks or tags	8%	47
4	Not identifying energy sources	10%	59
5	Lack of oversight	10%	61
6	Duplicate keys	2%	14
7	Not using them during minor servicing tasks	18%	106
8	Time constraints	14%	83
9	Other errors or mistakes	12%	71
10	Lockout/tagout procedures are very reliable in my facility	4%	27
11	Other (specify)	2%	12
77	DON'T KNOW	1%	7

The top four reasons why respondents believe lockout/tagout procedures may be unreliable are:

1. *Not using them during minor servicing tasks* (18%)
2. *Time constraints* (14%)
3. *Lack of training* (10%), and
4. *Lack of oversight* (10%)

Only 4% responded that "lockout/tagout procedures are very reliable in my facility" indicating that none of the other response might apply. Removing this answer and 'duplicate keys' (only 2%), the responses indicate a variety of reasons that make lockout/tagout procedures unreliable. There is no single or primary reason.

Additional comments submitted under the 'Other (specify)' response include situations where LOTO is evidently not feasible:

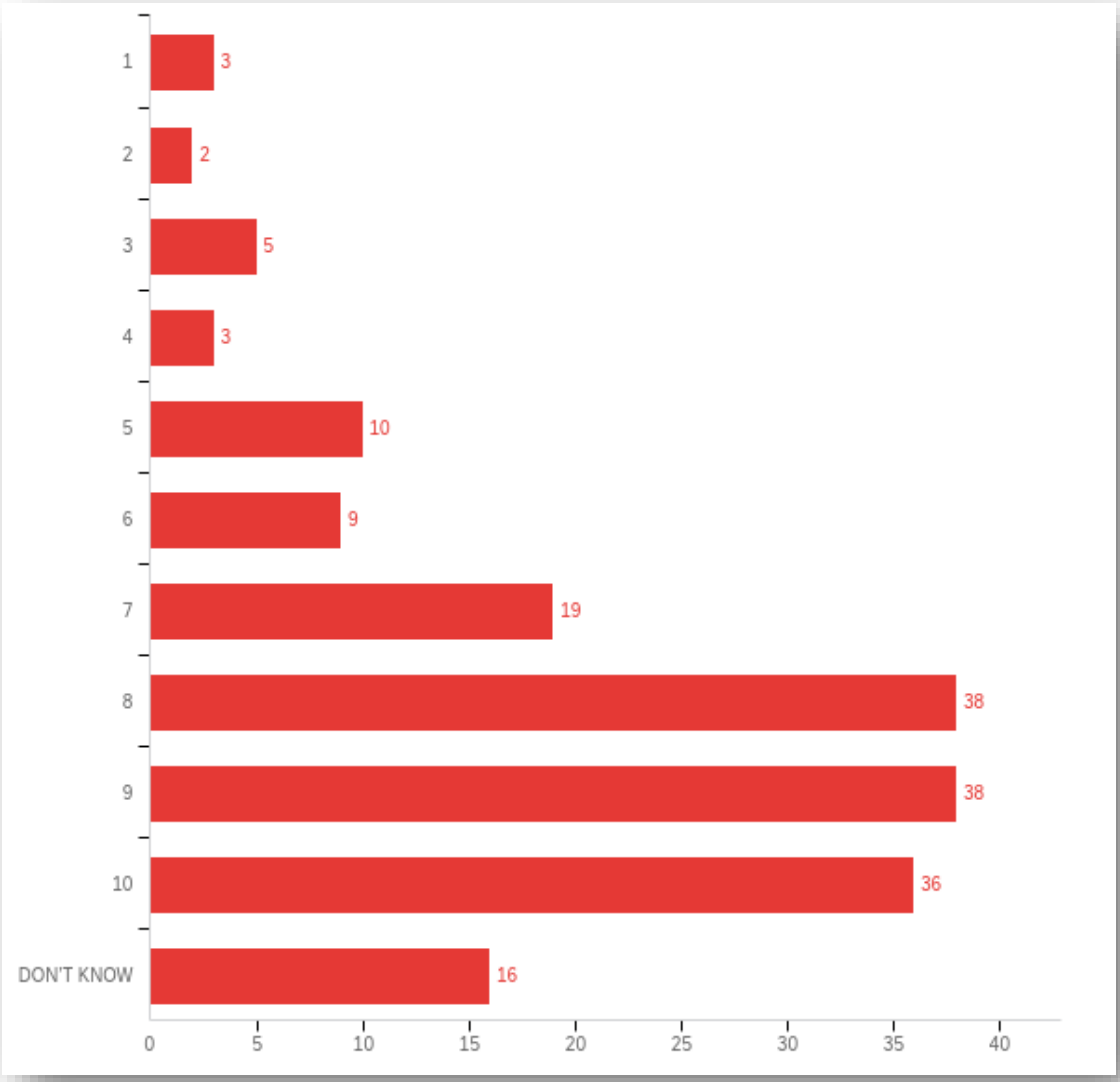
- Task cannot be performed under LOTO.
- Adjusting something when it must run.
- Not possible to turn off certain machinery when checking alignment because hydraulic pumps. must be running to hold machine parts into position.
- Machine commissioning.

Responses also included indications of employee behaviors or other errors:

- Employee attitude
- Never look at the written procedures
- Incorrect specification or implementation
- People believing they don't need it
- Lack of focus during lockout process
- Incentive for manipulation
- Need more specific clarity of minor servicing tasks

Rating of Alternative Methods reliability

Q6 – On a scale of 1 to 10, 1 being extremely low and 10 being extremely high, how would you rate the reliability of Alternative Methods in facilities like yours?



Regarding the rating that respondents would give to the reliability of the Alternative Methods in facilities like theirs, of the 179 responses, 112 were between 8 and 10 on the reliability scale. This means that 63% have high confidence in the Alternative Methods at their facilities.

Only 13 respondents (7%) indicated a very low confidence (rating 4 or lower) in the reliability of lockout/tagout procedures.

The average for this distribution of answers is 7.83, with a standard deviation of 2.10.

Q7 – In your opinion, what are some of the reasons that can make Alternative Methods in facilities like yours less than fully reliable? (Select all that apply)

	Response	Percent	Number
1	Lack of documented procedures	14%	63
2	Lack of training	13%	58
3	Incorrect use of locks or tags	6%	29
4	Bypassing or defeating a device	19%	83
5	Lack of oversight	11%	49
6	Duplicate keys	2%	11
7	Lack of maintenance/repair	8%	36
8	Other errors or mistakes	13%	57
9	Alternative methods are very reliable in my facility	9%	40
10	Other	3%	15
77	DON'T KNOW		

The top four reasons respondents believe Alternative Methods at facilities like theirs may be less reliable are:

1. *Bypassing or defeating a device* (19%)
2. *Lack of documented procedures* (14%)
3. *Lack of training* (13%), and
4. *Lack of oversight* (11%)

9% responded "Alternative methods are very reliable in my facility," indicating that none of the other response might apply. This is double the level compared to lockout/tagout (4%). Removing this answer and 'duplicate keys' (only 2%), the responses indicate a variety of reasons that make Alternative Methods less reliable. As with LOTO, there is no single or primary reason.

Additional comments submitted under the 'Other (specify)' response include:

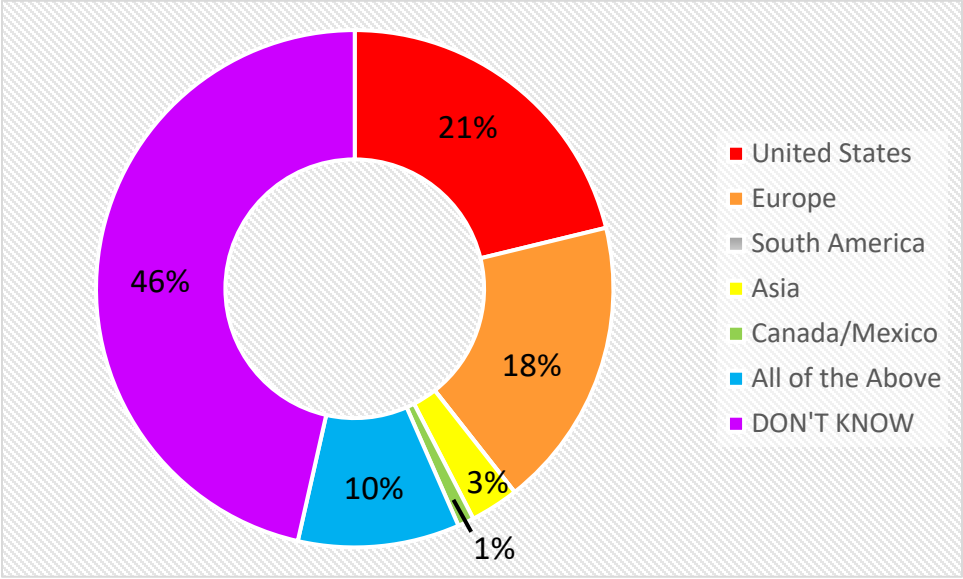
1. Those that appear not to trust Alternative Methods:
   - Alternative methods are not sufficient for some energy situations, i.e., e-stops are not sufficient for electrical energy, e-stops can fail!
   - Not providing same protection as LOTO that was applied correctly.

2. Indications of incorrect design or application:
   - Incorrect design for the risk
   - Lack of machine safety risk assessment
   - Inappropriate application
   - Not meeting necessary controls and performance levels
   - Older equipment restraints
   - Not all equipment is control reliable so identifying which equipment is the challenge.
   - We have situations where we don't have cat 3 control reliability with alt means procedures.

3. Errors in use of an Alternative Method and others:
    - Human error, complacency
    - Performing tasks outside of the capability of the Alternative Method
    - Doing tasks not approved for Alternative Methods
    - Using Alternative Methods for tasks not approved for use with the Alternative Method of control
    - Our PdM group "owns" our AMECs, other groups don't "own" them (sic).

Area of use

Q8 – To your knowledge, where are Alternative Methods used most frequently instead of lockout/tagout?

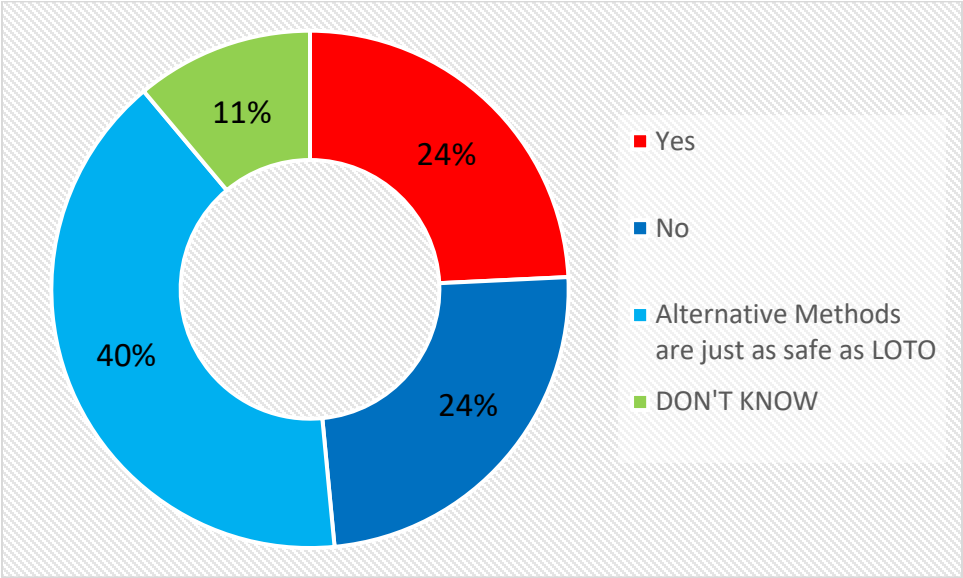


When asked if they know where Alternative Methods are most frequently used instead of lockout/tagout, the majority of respondents (46%) indicated that they did not know the answer to the question. On the other hand, 21% indicated that such usage was in the *United States*, while 18% indicated in *Europe*.

To answer this question effectively requires some level of familiarity with operations/regulations throughout the world, as well as the relationship between functional safety and Alternative Methods. This may account for the large number of 'Don't know' responses. Based on the responses, this was not an effective question.

Comparisons

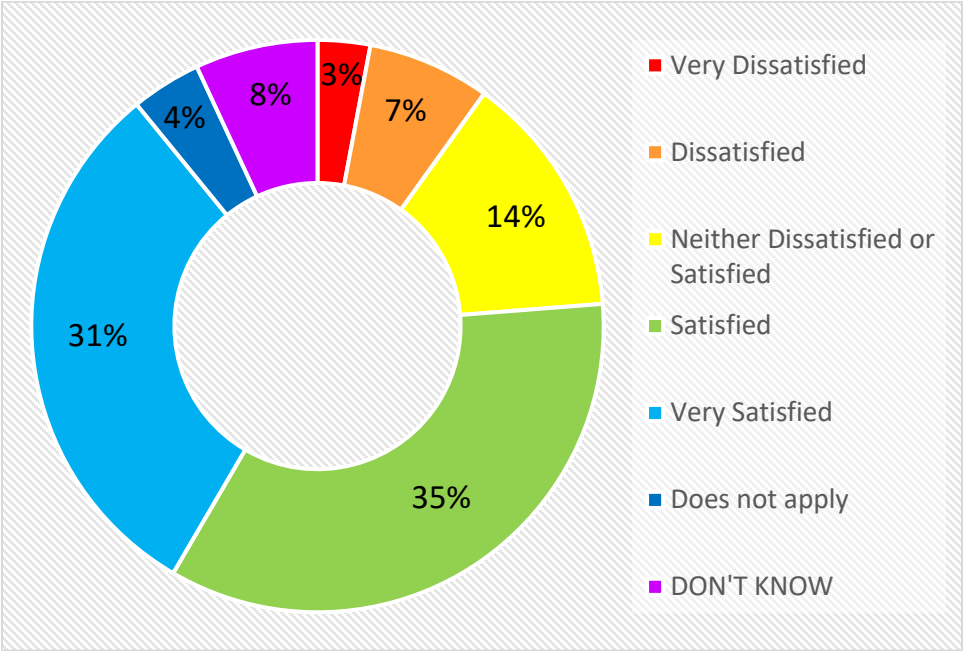
Q9 – In terms of practical application, do you believe Alternative Methods provide a safer solution to controlling hazardous energy than LOTO?



Regarding perceptions of "how safe" Alternative Methods of controlling hazardous energy are compared to LOTO, a significant number of respondents (40%) indicated that both are equally safe. Interestingly, there were identical responses to the *Yes* (24%) and *No* (24%) answers, indicating an equal number of persons hold opposite views to the other. That is, 1 in 4 respondents believe Alternative Methods are a safer solution, 1 in 4 respondents believe LOTO is a safer solution, with nearly the other 2 believing they are equal.

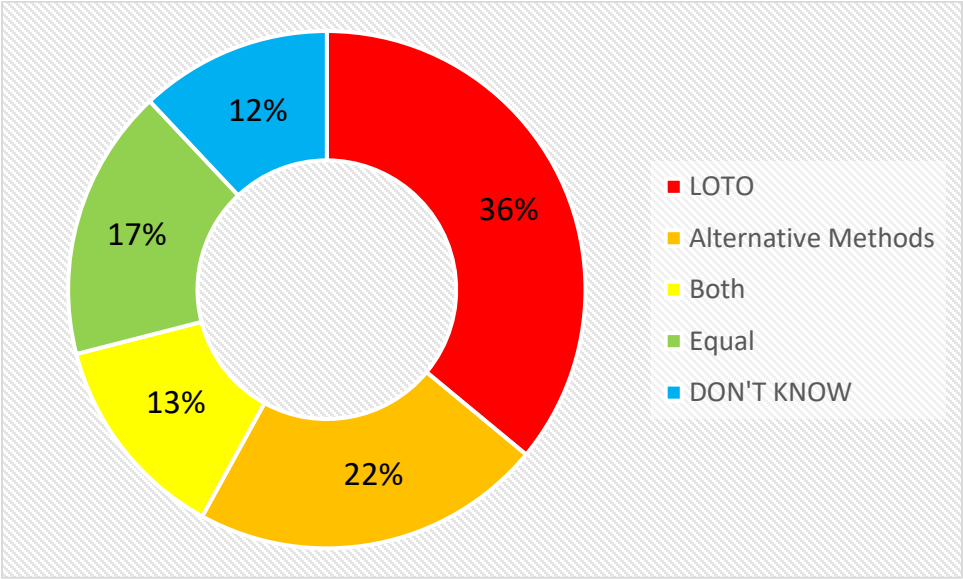
This largely reflects anecdotal discussions on the topic – wherein there is little consensus on the answer to this question.

Q10 – How satisfied are you with Alternative Methods in your facility in terms of preventing injuries?



When asked how satisfied respondents are with the Alternative Methods at their facilities in terms of injury prevention, 65% stated that they were *Very satisfied* or *Satisfied*. 10% indicated they were *Very dissatisfied* or *Dissatisfied*.

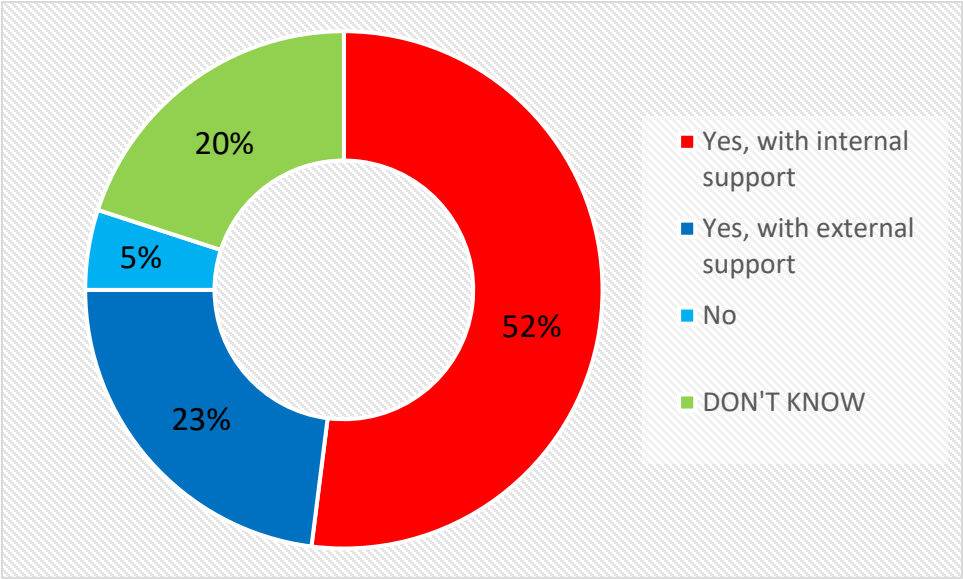
Q11 – In your opinion, which method for controlling hazardous energy is more likely to result in employee error?



Regarding the method to control hazardous energy that respondents perceive as the most likely to cause errors on the part of employees, 36% stated that LOTO was more likely, whereas 22% indicated that Alternative Methods were more likely to cause errors. This indicates there is at least a perception that LOTO has more opportunities for employee error. Combining the *Both* and *Equal* responses yields 30%, indicating no particular differences between the approaches.

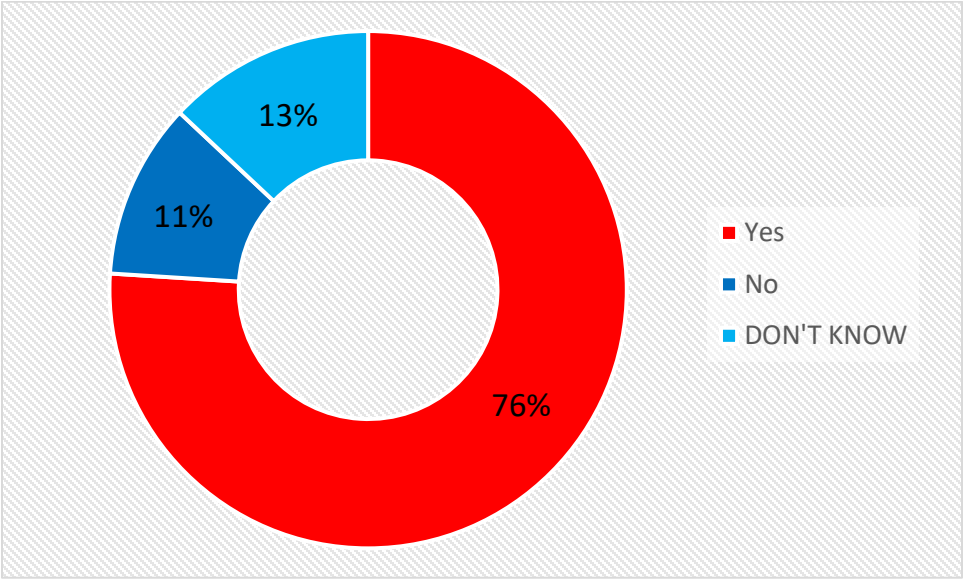
Smaller Enterprises

Q12 – In your opinion, can small to medium sized enterprises (less than 500 employees) use Alternative Methods to control hazardous energy?



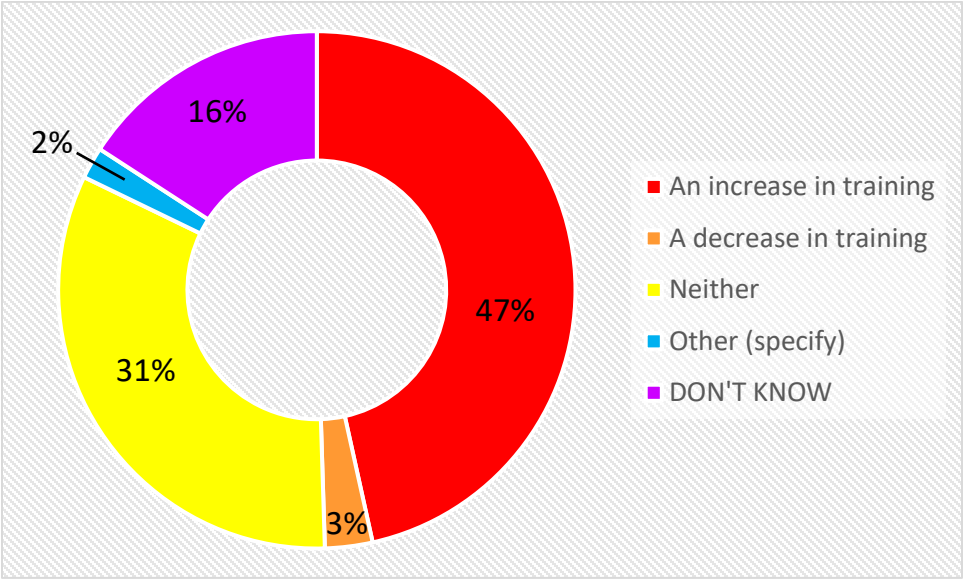
When asked if small and medium-sized companies can use Alternative Methods to control hazardous energy, 52% said *Yes*, as long as they have internal support. Likewise, 23% also said *Yes*, but as long as they have external support. Combined, 75% of the respondents believe small to medium-sized enterprises can use Alternative Methods with some support. Only 5% indicated they could not.

Q13 – In your experience, has your company been able to implement Alternative Methods with the skill set of your current employees?



76% of respondents stated that *Yes* their company has been able to implement Alternative Methods with the skill set of its current employees. Only 11% of respondents indicated *No*.

Q14 – Would you say the use of Alternative Methods in your facility has led to an increase in employee training for the control of hazardous energy, a decrease in the need for training, or neither?



Regarding the training needs for employees to use Alternative Methods in their facilities, 47% of respondents indicated that an *Increase* in training has occurred. On the other hand, 33% indicated that there was *Neither* an increase nor decrease in the need for employee training.

Only 3% indicated it led to a *Decrease* in training.

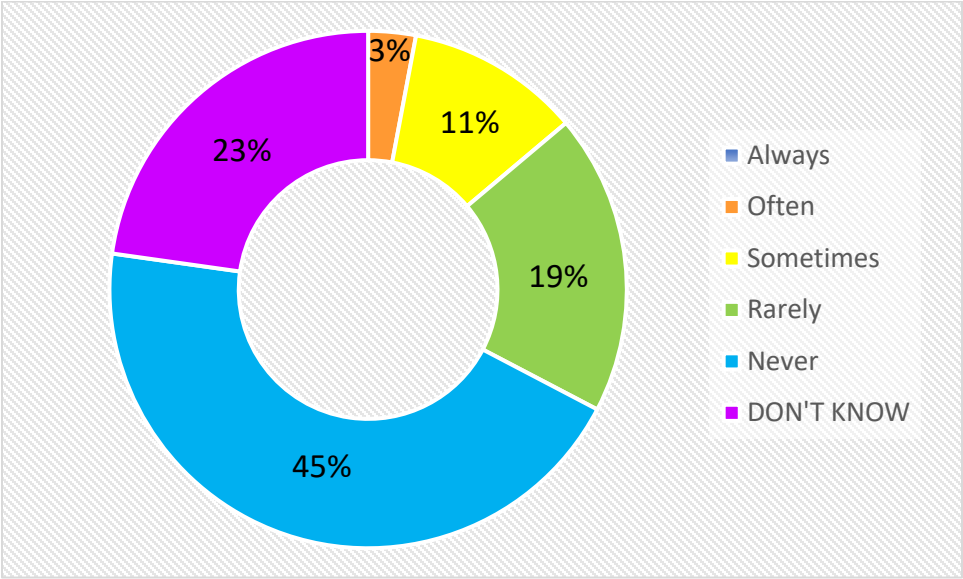
Additional comments submitted under 'Other (specify)':

- Alternative method is not depending on a person
- An increase to learning the alternative method.
- We had to train in more detail, so the employees understood the difference between LOTO and Alternative Methods

Based on the above responses the 2% of *Other* could be added to the increased training responses yielding 49% for increased training.

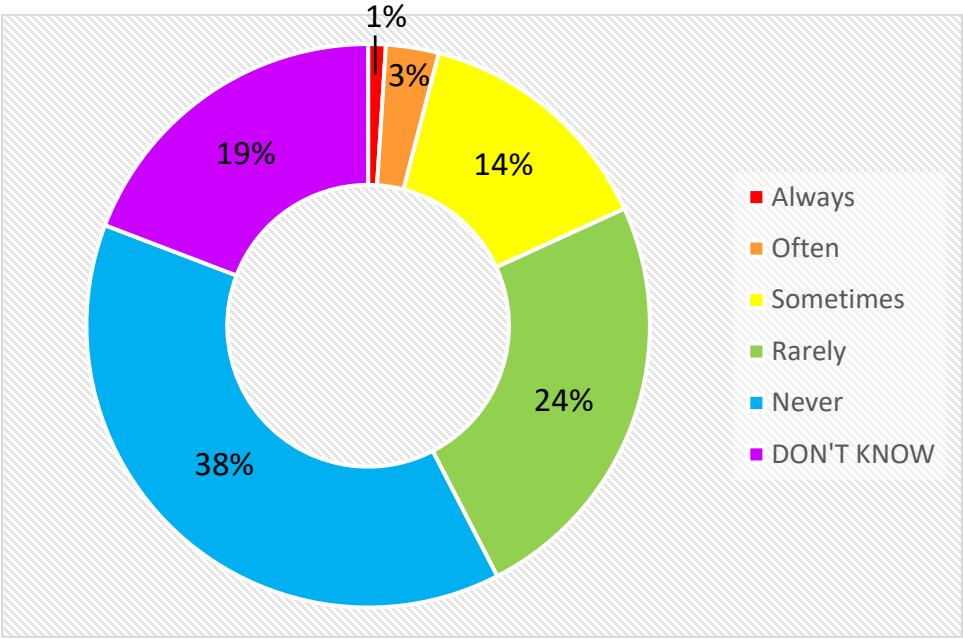
Disabling safety systems

Q15 – How often do you request a machine builder or your internal team to remove or defeat advanced safety systems to maintain compliance with OSHA's lockout/tagout requirements?



When asked how often they request to override advanced safety systems to maintain compliance with OSHA lockout/tagout requirements, the majority of respondents (45%) said *Never*. On the other hand, 23% indicated that they did not know. 19% indicated that they *Rarely* do, with 11% *Sometimes* and 3% *Often*. Combining *Rarely*, *Sometimes*, and *Often* yields 32% indicating that overriding occurs with about 1/3 of the respondents.

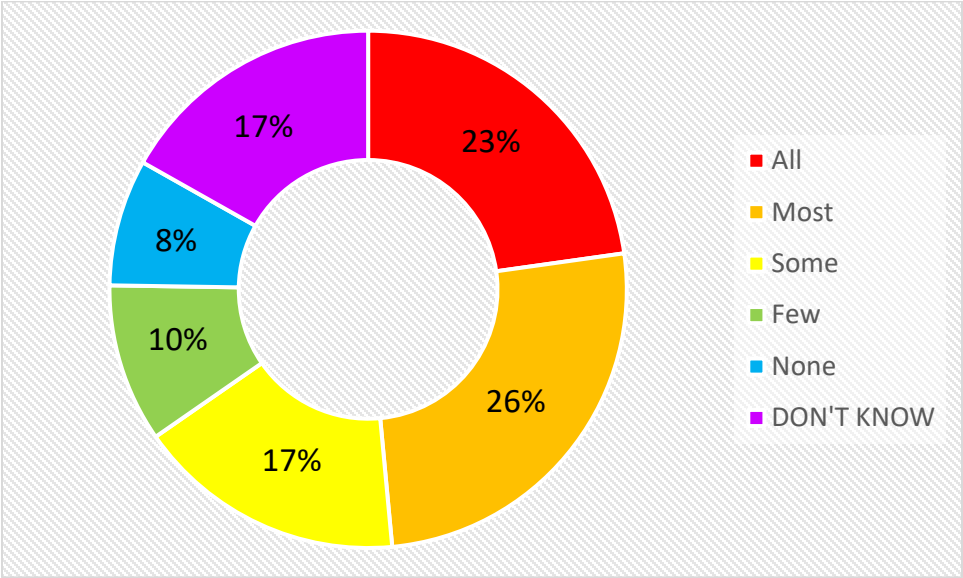
Q16 - How often do you disable or work around equipment's safety systems to maintain compliance with OSHA's lockout/tagout requirements?



When asked how often they disable or bypass equipment safety systems to maintain compliance with OSHA lockout/tagout requirements, 38% of respondents indicated they *Never* do so. The second most important group was those who indicated that they *Rarely* do it (24%), while 19% indicated that they *Don't know*. *Always* (1%) is an indicator that this person(s) believes safety systems inhibit operations. *Rarely* and *Never* combined to yield 72%, indicating about ¾ of the respondents do not override safety systems. Conversely, *Always*, *Often* and *Sometimes* yield 18% indicating this does occur in industry.

Documentation

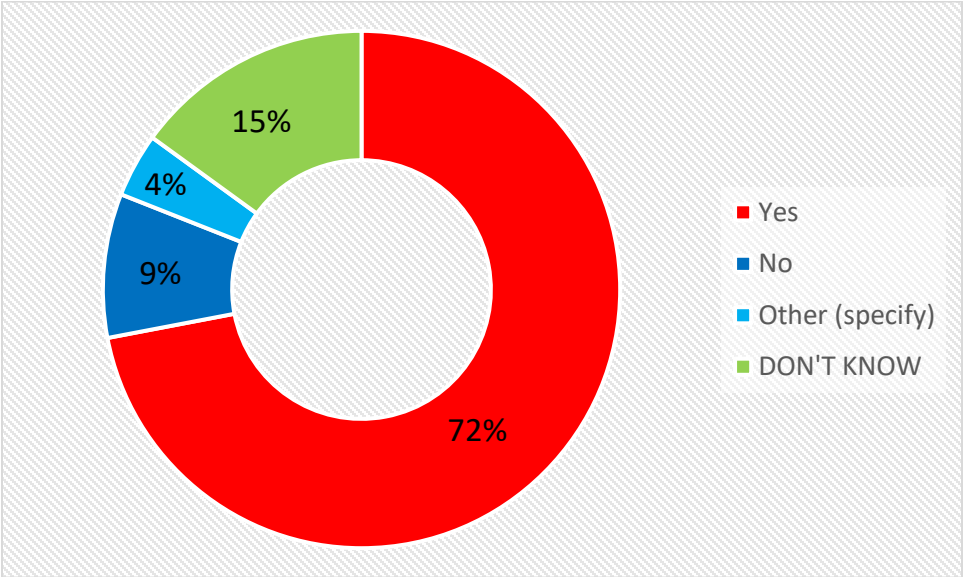
Q17 – How many of the Alternative Methods used in your facility have a documented risk assessment and other supportive documentation?



When asked about the number of Alternative Methods that have a documented risk assessment and other supporting documents in their facilities, 26% of respondents stated that *Most* of them do. Likewise, 23% indicated that *All* have them. Combining *All* and *Most* yields 48%. Adding *Some* and *Few* to these yields 75% have some level of supportive documentation. Only 8% indicate there is no supporting documentation.

Adopting ANSI Z244.1

Q18 – In your opinion, should OSHA consider adopting the ANSI Z244.1 standard that specifies requirements for Alternative Method and control circuit devices as part of an updated OSHA standard?

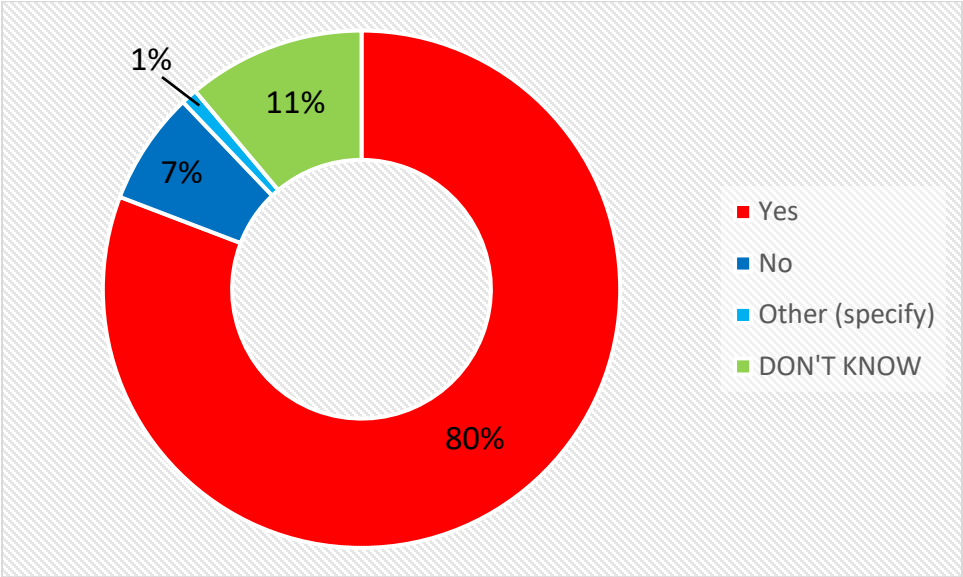


The majority of respondents (72%) agreed with OSHA adopting ANSI Z244.1. Only 9% disagreed.

Additional comments submitted under 'Other (specify)':

- On the fence
- Some parts of Z244.1
- Maybe parts. Not straight
- ISO 13849 (*Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*)
- Certain elements

Q19 – The ANSI/ASSE Z244.1 consensus standard encourages the use of risk assessment and hazard control hierarchy as Alternative Methods of hazardous energy control. In your opinion, should OSHA consider incorporating these methods in any new standard with respect to the use of machinery circuits and devices to control energy(s)?



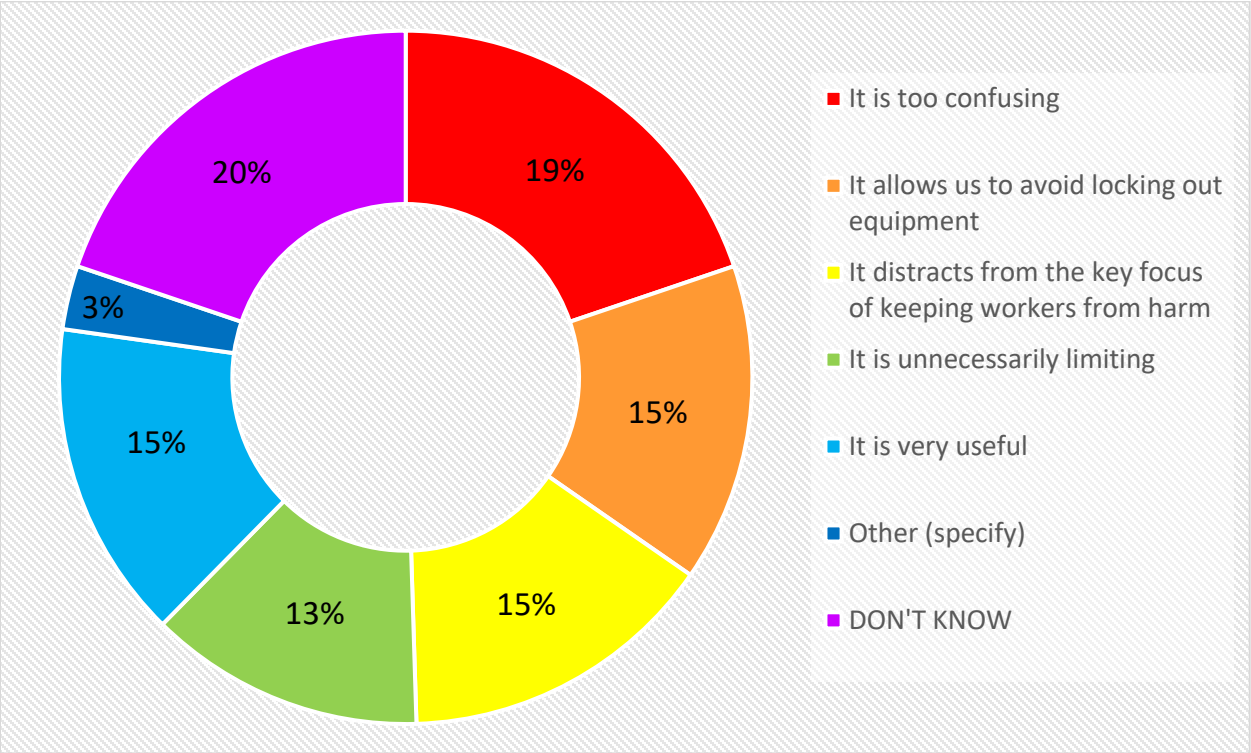
80% of respondents agreed that OSHA should incorporate risk assessment and the hazard control hierarchy in determining the methodology for controlling hazardous energy. Only 7% disagreed.

Additional comments submitted under 'Other (specify)':

- New installment
- Risk assessment is the starting point for keeping people safe.

The Minor Servicing Exception

Q20 – What is your view of the minor servicing exception under 1910.147? (Select all that apply)



When asked about the minor servicing exception according to 1910.147, the opinions of those surveyed varied greatly. On the positive view, 30% thought the minor servicing exception is very useful and allows the ability to not lockout equipment. On the negative view, 47% consider the minor servicing exception in more negative terms (confusing, limiting, distracting).

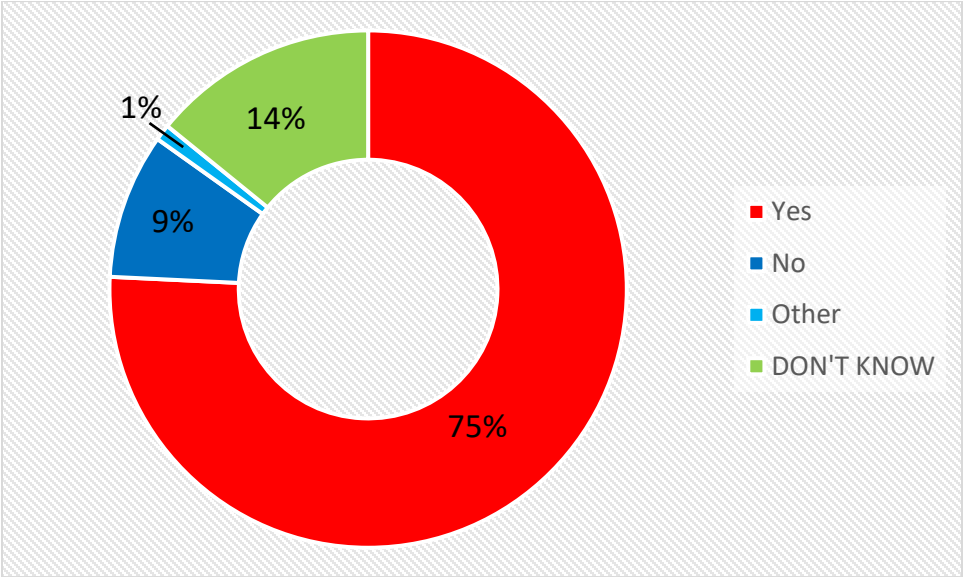
This response distribution reflects that there are varied views of the minor servicing exception. The results are consistent with the confusion surrounding the plain language of the exception as written versus the very narrow interpretations commonly cited.

Additional comments submitted under 'Other (specify)':

- The minor servicing exception should go away. It is no longer relevant or useful if you follow Z244.1
- Not well defined when it can be used.
- We must have the ability to repetitively and routinely service our equipment.
- Great for specific PM tasks
- It is very safe and useful for our production but it is sometimes difficult to explain when it can be used. i.e., what does repetitive mean?
- Often misinterpreted.

Most of the comments reflect the challenges of the minor servicing exception – not well defined, difficult to explain, misinterpreted, etc. Other responses reinforce the idea that Alternative Methods are necessary because some tasks are not feasible under LOTO. In this case they view the minor servicing exception as the means to perform the task using an Alternative Method.

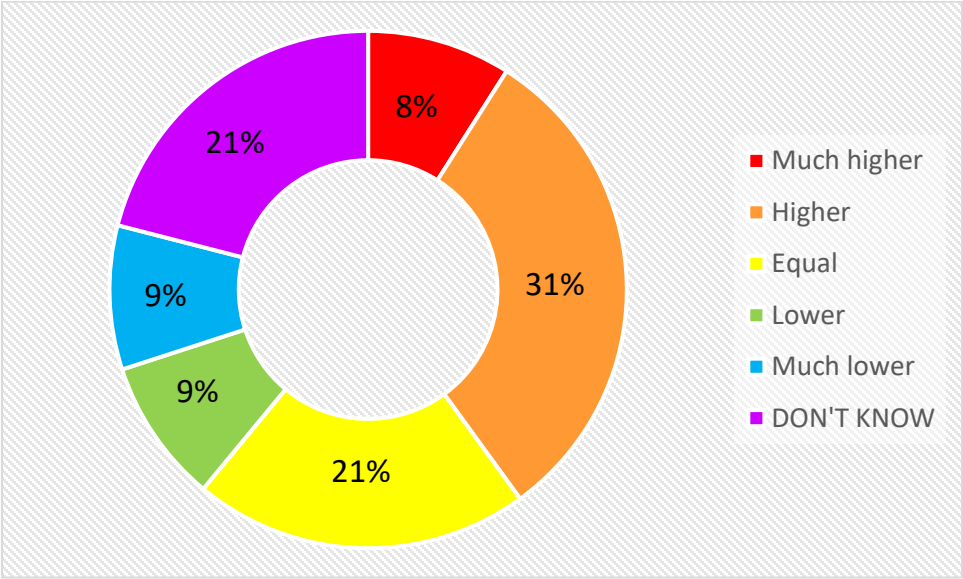
Q21 – The ANSI Z244.1 consensus does not place a restriction on the type of task (such as service or maintenance) that can be performed using an Alternative Method. It requires that tasks performed using an Alternative Method be evaluated in accordance with the standard. Should OSHA consider allowing a similar approach and allow employers to determine what protective measure to apply?



When asked if OSHA should allow employers to determine which protective measure to apply, 75% of respondents agreed with this approach. Only 9% disagreed. The results indicate a strong lack of support for a list of specific tasks that are allowed/disallowed under either LOTO or Alternative Methods.

Costs

Q22 – To your knowledge, are the relative overall costs of ownership of Alternative Methods (including installation, training, operation and maintenance) higher, lower or equal to the costs of using LOTO?



Regarding the perceptions of the costs of ownership of Alternative Methods, 40% of those surveyed indicated that these seem more expensive than those of LOTO (*Much higher* and *Higher*). On the other hand, 21% indicated that the costs seem *Equal* as those of LOTO, and only 18% consider that the Alternative Methods costs are lower (*Lower* and *Much lower*).

Impact on production

Q23 – What would be the immediate impact on production if your facility was required to use LOTO instead of an alternative method? (Max 200 words)

This question afforded respondents the ability to provide their views on the immediate impact of production at their facility if only lockout was required. The responses have been grouped in the following general categories for convenience. Some of the responses bridge more than one category. The responses are nearly verbatim with only editorial corrections made.

Alternative Methods Skeptics (3)

1. It's about keeping people safe, energy must be effectively controlled, using electronic circuits to try to control hazardous energy is a hazard!!!
2. Positive sound and safe.
3. I feel it would be slicer kite (sic) in the long run to require LOTO. I also feel people may be more apt to not do LOTO to save time, which is more concerning.

Unknown impact (5)

1. Unknown.
2. Don't know.
3. No opinion, no idea of frequency that it would occur.
4. Don't know.
5. Cannot say.

Minimal impact (9)

1. It would probably be minimum impact. We don't use a lot of Alternative Methods.
2. Minimal.
3. Minimum. When my company uses Alternative Methods, realistically its in coordination with LOTO. It's more of a do both, not do one or the other, situation.
4. Slight
5. None
6. None, already using LOTO without Alternative Methods.
7. None
8. None
9. Hard to say I think it would have little to no impact.

Production – General (22)

1. Adversely impacted; many LOTO tasks are not operator-executable and require an electrician to enter an MCC to de-energize and re-energize. This adds significant time/effort to the LOTO process.
2. We will start losing money on some of the machines with an Alternative Method.
3. It would slow down production.
4. A decrease in productivity that would be difficult to recover from. Too many tasks need energy to be available while Alternative Methods are in use.
5. Significant increase in operation costs and reduction of products produced. As well as increased risk of missing procedures.
6. Less daily output= less $
7. THERE ARE SIGNIFICANT PRODUCTION LOSSES DUE TO THE TIME CONSUMPTION OF LOTO VS ALTERNATIVE METHODS
8. Significant slow down to production.
9. Severe decrease in machine running rate.
10. Loss of product, loss of revenue.
11. This would cost a great deal of money and time.
12. Production would be lowered drastically.
13. Loss of production.
14. Decrease in production.
15. It would slow down production and would reduce productivity.
16. Would be a significant impact on throughout/production.

17. Production done on large systems. Alternative Methods allow for interruption of small sections of the system where the rest remains in production. LOTO would require stopping everything.
18. Longer build time.
19. Reduce productivity.
20. In several instances production would be negatively impacted due to multiple lockout points and difficulties with restarting after the power off state.
21. We need to use Alternative Methods to maintain quality and efficiency of the process to stay competitive with the market place.
22. OEE will decrease significantly (Overall Equipment Effectiveness)
23. It would go down.

Production – Downtime (14)

1. More machine downtime and less safe operating conditions.
2. Potential increase in service time
3. Major spike in equipment downtime, inability to meet production goals due to minor occurrences
4. It would likely cause longer downtimes which may prompt employees to take shortcuts and have less effective protection measures in place.
5. Lower production due to downtime.
6. Much more Downtime, more injuries from neglect or less likely to use LOTO for quick tasks.
7. Increased down times while locking out instead of using alternative or safeguarding methods. Also compliance with LOTO could suffer as workers choose to take unnecessary risk to save time or effort.
8. LOTO method requires more time to secure machinery, and consequently restore machinery to production than Alternative Method. Plus, the possibility an energy point could be missed.
9. Production interruptions would be lychee (sic) greater.
10. More downtime on the production line
11. Downtime, loss of profit.
12. No impact on Safety however more time would be needed to accomplish the task.
13. Could slow maintenance and ultimately production.
14. Costs would go up. Work time increases, Equipment down time increases less PM/repairs completed in the same time frame due to increased LO time.

Production – Service (3)

1. The recovery time to restart from minor stops/jams would be much longer. It would also make changeover (which uses info & prompts on the HMI) more difficult.
2. Reduction in production due to the wasted time especially when troubleshooting equipment.
3. Productivity will be impacted, equipment restart longer, employees less likely to use LOTO due to time constraints for short tasks.

Production – Quantified impact (6)

1. I believe it would take 5-10 times longer to perform some of the tasks required if the operator needed to follow the complete LOTO from OSHA.
2. In a lot of cases we still have situations we can isolate most of our production lines. It would shut down the line for up to 1-2 hours.
3. When engines come off the end of the conveyor every 30 seconds, it would be huge. Our downtime is measured in seconds, not minutes or hours.
4. We would lose millions of dollars, shut down customers, etc.

5. Reduction of cycle time by more than 30 minutes for each defined task.
6. A reduction of production between 15 and 20 %.

Production – Significant impact (7)

1. It would prevent us from using some equipment immediately.
2. Higher
3. Significant
4. Tremendous Lost Time
5. It would be costly to us.
6. A lot
7. Absolutely. This would be a huge impact for US operations.

Production – Safety and Behaviors (7)

1. Significantly increase in costs and cause serious production delays with no increase in safety
2. It would create a massive incentive for intentional disregard for such a rule due to unacceptable reduction in productivity and perceived unreasonableness.
3. Production would decrease and frustration would increase.
4. Extremely decreased production and morale. May would question "why was it okay yesterday and now it's not?"
5. Tasks which require power, or which can be safely accomplished limited power are facilitated. Machine up-time would increase as the Alternative Methods may be implemented easily and quickly.
6. Lost productivity due to longer time to make adjustments and higher risk of LOTO errors.
7. There would be some tasks that would limit production greatly. In some cases it could cause operations to find "work arounds" that are less safe than either option.

Inability to run (10)

1. It would be almost impossible to produce products with the age of our equipment. Many of our machines have so many isolation devices it would take too long to LOTO.
2. It would shut most all facilities down, you cannot use LOTO 100% of the time. It is foolish to think we need to use LOTO when we can eliminate the exposure to HE (hazardous energy).
3. We use Alternative Methods on our robot areas. Only it would affect teaching the robot which needs to be done with power on.
4. If the repetitive and routine adjust was not allowed we could not operate our equipment and would not be in business.
5. There are many process tasks that could not be completed safely if Alternative Methods were not allowed.
6. Some machines take an extremely long time to bring back up and can lose data if completely powered down.
7. Some troubleshooting and minor servicing requires machine power. LOTO in every situation would actually put workers more in harms way by trying to cheat the LOTO.
8. Won't work if we isolated for everything.
9. Some tasks are infeasible with LOTO.
10. We would not be able to produce parts for customers.

Other (11)

1. Extra time consuming and based on the production pressure LOTO often is short cutted. Using alternative, person independent removal of hazardous energies requires less training and is direct available.
2. All of these questions would be dependent on the operations/environments. Many of the challenges we face is multiple architectures throughout the years, and the inability for the employer to enforce.
3. Could drive some manufacturing to other countries.
4. We would have to resort to manual tasks while risk assessments, procedures, and training were developed and deployed.
5. It would only involve the maintenance department and it would make troubleshooting more difficult.
6. Likely we would see an increase of minor injuries.
7. Would be less safe.
8. Loads of time due to increased training.
9. Reduced equipment availability. Potential increase in LOTO violations.
10. Mean time to repair would greatly increase as well as greater risk of exposure/injuries due to the fact that many alternative means are passive (i.e., fail to safe) than compared to LOTO.
11. Increased MTTR (Mean Time To Repair).

Q24 – What type of industry does your company belong to?

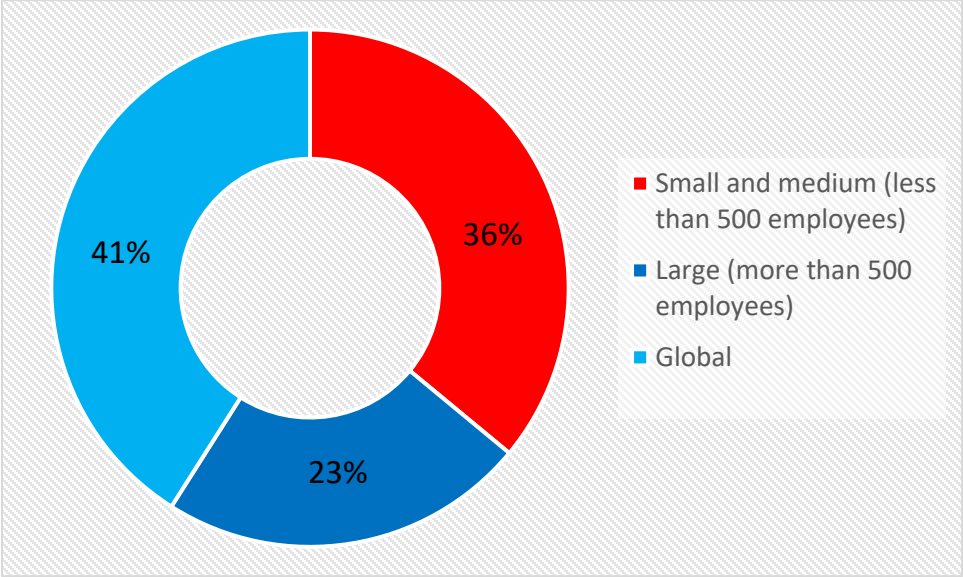
	Industry	Percentage	# of Responds
1	Agriculture	2%	5
2	Automotive	16%	43
3	Chemical	2%	5
4	Energy	1%	4
5	Food	5%	13
6	General Manufacturing	16%	43
7	Health	2%	6
8	Labor	1%	2
9	Legal	<1%	1
10	Material handling	5%	14

	Industry	Percentage	# of Responds
11	Machine tool/machinery	8%	22
`12	Metals manufacturing	12%	32
13	Packaging and processing	7%	19
14	Pharmaceutical	3%	8
15	Plastics	2%	6
16	Precision metalforming	5%	15
17	Pulp paper and converting	4%	12
18	Semiconductor	4%	10
19	Other	5%	13
			273

The industries most represented (>10%) include: automotive, general manufacturing, and metals manufacturing. In general, the mix of industries provides meaningful results for the control of hazardous energy topic that impacts many very different industries.

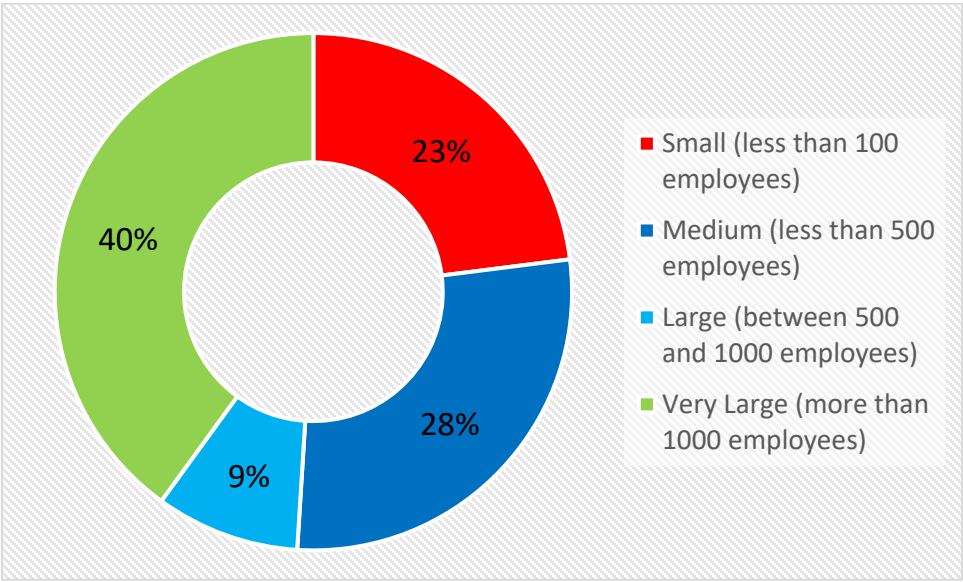
Demographics

Q25 – Which best describes your organization size?



The survey respondents represented a very good sample from organization sizes small and medium, large and global enterprises. No category dominated or was under-represented.

Q26 – Which best describes your facility size?



The survey respondents also represented a very good sample from facility sizes including small, medium, large, and very large enterprises. Again, no category dominated or was under-represented.

Implications

Survey Demographics

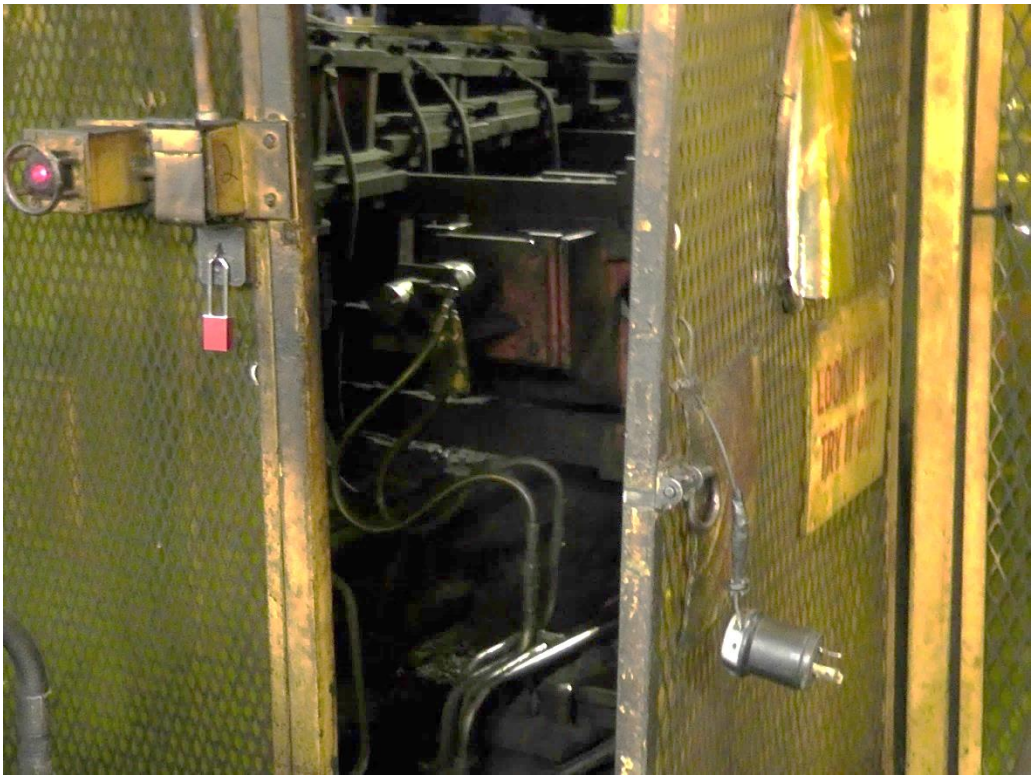
Between the sample size, the mix of suppliers and users, and the mix of company sizes and facility sizes, the survey offers reasonable perspectives on the challenges for the control of hazardous energy. The survey results are reasonably representative of the views of the target audience and can be relied upon for further analyses.

The questions and responses provide very useful and insightful data to inform the discussions on the control of hazardous energy.

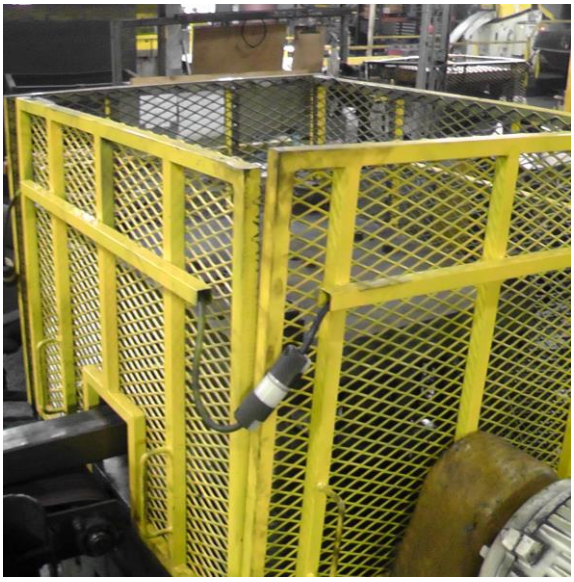
Technology Skeptics

Question 23 and others highlighted that some of the respondents harbored some skepticism over the use of Alternative Methods. Three respondents clearly indicated they believe lockout tagout is a better and safer solution. One commenter correctly stated: "Alternative methods are not sufficient for some energy situations, i.e., e-stops are not sufficient for electrical energy, e-stops can fail!"

This perspective is not without merit. Blind reliance on control systems can be misguided. Determining if an Alternative Method or control system is well designed and suitable for the application can be challenging. There are also plenty of examples of functional solutions that "work," but are not at all suitable for use in the application. For example, the following real-world situations where inadequate Alternative Methods have been observed:

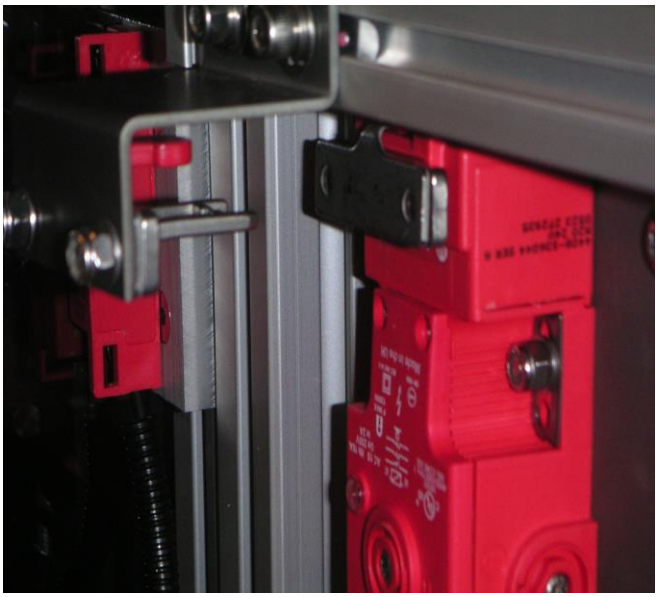


Cord connector used to "interlock" access to machinery.



Cord and plug system used as an “interlock” for guarding access to a machine.

Category 4 rated switch not applied per manufacturer’s requirements or relevant standards, and thus subject to a single point of failure due to mechanical application issues, i.e., chain (breakage) or fastener (single button head screw barely larger than the chain link).



Bypass “cheater key” inserted into switch allows access panel to be opened with the equipment operational and thus defeating the Alternative Method.

The mere presence of a safety control system does not indicate a valid Alternative Method. ANSI Z244.1 does not specify particular control devices or reliability levels. However, devices must be part of an appropriately designed control system that takes into consideration factors like risk assessment, reliability requirements for functional safety, exclusivity, tamper resistance, fault tolerance/annunciation, and common cause failures. Proper design, installation, and maintenance are all required to provide the appropriate reduction of risk. Many of these same requirements apply to LOTO as well.

Although some skepticism can be healthy, as reflected in this survey, if an Alternative Method is designed, installed, used, and maintained correctly, these systems can keep workers safe from harm.

Impacts

Suppliers indicated that only 10% have systems that *Never* or *Rarely* include Alternative Methods. Half (48%) of the suppliers indicated that they include safety devices as Alternative Methods.

Question 23 captured the breadth of concerns respondents shared over the impacts on production if lockout was the only means allowed to control hazardous energy. Three respondents expressed the view that LOTO is a better approach. There were five respondents who did not know the impact. There were nine respondents who believed such a change would have minimal or no impact.

The vast majority of respondents indicated that such a rule would have significant negative impacts on production in a variety of ways.

- Many cited general impacts to production and the ability to supply their customers with products, with one noting that their large systems are zoned to allow Alternative Method interventions without stopping the entire process. LOTO often requires stopping the entire system.
- Many indicated only general descriptions (drastically lower, severe impacts, huge costs).

- Several highlighted the impacts on behaviors – the perceived unreasonableness of the rule, increased frustration, incentives to take shortcuts, lower morale, and increased errors if only LOTO was allowed.
- Others highlighted the extended downtime and service to isolate power sources and then restart. Some pointed out that many tasks require energy to be performed, that LOTO is not operator-executable, and the difficulties with restarting from the power off state.
- One respondent noted the carryover effects such as reduced PMs or repairs on other equipment
- Additional comments pointed out impacts on quality, efficiency, competitiveness, including that work might be moved to other countries.
- Those respondents who shared quantitative answers provided additional insights:
    - 5-10 times longer,
    - up to 1-2 hours downtime,
    - downtime measured in seconds, not minutes or hours,
    - millions of dollars and impacts to downstream customers,
    - would add 30 minutes for each defined task,
    - 15-20% production loss.
- Quite a few indicated that their facility would not be able to run if such a rule prohibited the use of Alternative Methods.

Taken as a whole, the responses to Question 23 indicate that Alternative Methods are a necessary and important means to control hazardous energy in industry today.

Implications of Global Competition

In the late 1970s and early 1980s the U.S. was an unequaled leader in global manufacturing. Over the years, global competitiveness is such that U.S. manufacturers must now compete with organizations from all parts of the world. Unfortunately, not all competing nations or companies have the same respect for personnel safety as in the U.S. The U.S. should not, and cannot, race to the lowest common denominator. It should continue to hold paramount the safety and health of customers and workers. However, the U.S. is no longer able to support systems that take an arbitrary "blanket" approach to safety. Overly conservative or antiquated safety systems may be unnecessary if Alternative Methods achieve acceptable risk. When solutions exclude modern technology, then the cost of equipment and the cost of using, operating, and maintaining the equipment renders the operations uncompetitive.

Competition forces industry to deploy resources as effectively as possible. In the book *On the Practice of Safety*, Fred Manuele (2013) stated that:

> Resources are always limited. Staffing and money are never adequate to attend to all risks. The greatest good to employees, to employers and to society is attained if available resources are *effectively and economically* applied to avoid, eliminate, or control hazards and the risks that derive from them… safety professionals must be capable of distinguishing the more significant from the lesser significant. (pp. 55-56) *(emphasis in original)*

The inability to use Alternative Methods based on advancing technology is creating significant operational and safety challenges for suppliers and machinery, equipment, and process users across many industries.

The ability for U.S. companies to compete in the global market is a valid consideration in terms of the control of hazardous energy. As noted by some respondents, requiring LOTO to be used when competitors can rely on Alternative Methods puts U.S. companies at a competitive disadvantage. Respondents highlighted such concerns, including the potential for work to be shifted to other countries, and the impacts on production if Alternative Methods were no longer allowed to be used.

Size matters not

Question 12 inquired about the ability of small and medium-sized companies to use Alternative Methods. OSHA and others have expressed great concern that smaller organizations may not be able to apply available methodologies for the control of hazardous energy. More specifically, OSHA cannot write rules that are only able to be used by larger organizations. The responses to Question 12 clearly indicated that according to this sample, small and medium-sized organizations are able to use Alternative Methods (75%). Only 5% indicated these smaller organizations cannot successfully apply Alternative Methods.

Independent of the size of the organization, 76% of respondents indicated in Question 13 that their company has been able to implement Alternative Methods with the skill set of its current employees. This indicates that the use of Alternative Methods should not overly burden employers to use Alternative Methods in terms of hiring new workers.

In Question 14, 49% of the respondents indicated that using Alternative Methods did require increased training, whereas 33% indicated neither an increase nor decrease in training. These results suggest that some companies should expect additional training will be needed to implement and use Alternative Methods.

It can also be noted that the OSHA requirements for LOTO documentation – programs, procedures, hardware, and management of change can be quite burdensome. These requirements are justified, as are the requirements of Alternative Methods. The burden of implementation will likely be similar to those of LOTO.

Legacy Systems

The results of this survey may be influenced by the mix of legacy machinery in use, but to what extent is unknown. Newer machines tend to be more likely to incorporate Alternative Methods, whereas older legacy machines often do not. As older machines are retired, one can expect that newer machinery, equipment, and processes incorporating Alternative Methods (functional safety) will continue to enter the workplace.

The Relative Reliability Issue

Which is more reliable – LOTO or Alternative Methods? When viewed in the hazard control hierarchy, engineering controls are considered more preferred and more reliable than administrative controls such as LOTO. According to the hierarchy of controls, relying on engineering controls, including safety-related control systems, is preferred over administrative controls such as lockout. Using reliable control systems can minimize the potential for human error – both intentional and inadvertent – by simplifying the control of potentially hazardous energy.

One might expect that this preference would manifest itself in the responses. However, the respondents view the reliability of LOTO and Alternative Methods at remarkably similar levels.

	LOTO	**Alternative Methods**
High confidence	58%	63%
Very low confidence	9%	7%
Mean	7.39	7.83
Standard Deviation	2.15	2.10

Comparing the High and Very low confidences between lockout/tagout and Alternative Methods, there is little difference registered: 58% vs 63% (High) and 9% vs 7% (Very low). Similarly, the mean and standard deviation measures are remarkably close.

This indicates that respondents have generally high confidence in the systems in place at these facilities, and that they do not see a significant difference between the reliability of these approaches. In general, the potential for human error is considered higher for procedures such as LOTO, but at the respondents' facilities this potential did not manifest itself in the responses.

Yet the results of Question 11 demonstrate a smaller difference than might be expected in the perceived reliability of LOTO compared to Alternative Methods. Although 36% indicated that LOTO was more likely to cause errors on the part of employees, 22% indicated the opposite – that Alternative Methods is more error provoking. In addition, 30% indicated no particular differences between the approaches (combining the *Both* and *Equal* responses).

Combined, the results of this survey call into question the underlying premise that Alternative Methods are more reliable than LOTO based on the hierarchy of controls. The results suggest that the perceived difference in errors is likely less than typically presumed. In the end, the failure rate of a properly designed Alternative Method tends to be much lower than the failure rate associated with LOTO application because LOTO relies on people not making mistakes.

Reliability of modern control systems

One of the unfortunate consequences of OSHA's enforcement efforts is that OSHA has interpreted the rules to exclude all control systems as Alternative Methods – regardless of the reliability of the control system (see Main and Grund 2016). The relevant comparison is not whether modern control systems can provide reliable performance compared with a metal lock on a disconnect switch. Instead, the evaluation should consider how reliably the lockout procedures will be followed and the lock installed, versus the performance of the Alternative Method using an engineered control system.

A reasonable conclusion from this survey, the literature, and experience shows that lockout procedures, when used, reliably control potentially hazardous energy.

Another reasonable conclusion is that lockout procedures are not always reliably used, or are not as reliable as all might assume.

A primary conflict exists in that even though current technology offers solutions using Alternative Methods, the OSHA standards, definitions, and enforcement activities do not readily allow the use of these solutions. The application, the reliability and quality of the components used, how the components are combined, and the ability of the system to detect if something goes wrong all play a role in determining the safety performance or adequacy of the control system.

Control systems are not an absolute solution. The reliability of control systems must also be considered. There are many applications where full energy isolation using LOTO is the best and most appropriate solution to keeping workers safe from harm.

Technological innovation can, and should, continue to bring advances in safety, security, and productivity. New ways to achieve the control of hazardous energy should be encouraged rather than prohibited where appropriate. However, methods new and old must allow for the necessary tasks that need to be completed safely by appropriately controlling potentially hazardous energy. The major question becomes how to make that happen.

Unfortunately, there is no simple checklist or component marking way that confirms if a control system is safe enough without digging into the details. Even high-quality components can be, and have been, combined in poor designs to yield poor (and expensive) results. The necessary analysis adds value because properly designed control systems simultaneously improve safety and productivity – and thus should be encouraged rather than discouraged.

The proper design of a functional safety system *is* electrical engineering, just as proper design of a structure requires mechanical engineering. Determining design requirements, selection of proper components, and proper installation are all a part of the process. The wrong bolts, improper tightening, or failure to consider the conditions of use all can result in a dangerous failure of a bridge. Proper design of a bridge or a functional safety system both rely on sound engineering principles, and there is no 'shortcut' to determining good or bad.

Today, many methods exist for evaluating the reliability of functional safety systems. The reliability is required to be commensurate with the risk - where the risk of harm is low, a less reliable control system may be appropriate. For higher-risk applications properly designed control systems can be sufficiently robust to prevent a single fault in the control system from resulting in the loss of the safety function. Failures will still occur, but properly designed and constructed control systems will not allow the failure to result in the loss of the safety function and workers to be harmed.

Complexity

In earlier times, machinery, equipment, and processes were relatively simple, and so too was controlling the energy sources. Machinery was often binary – many machines had a single drive motor and it was either On or Off, energized or de-energized. That is no longer the case in many situations. A robot cell can contain hundreds of motors, hydraulic, and pneumatic actuators. Complex interactions between systems can make "switching it off and then testing to make sure it's off" quite a challenge.

The added complexity offers both challenges and opportunities. Some of the challenges include: knowing the energized state of the system, controlling the energy appropriately, and establishing the confidence to know the answers are correct. Some opportunities include: safer and faster operations, ease of use, improved productivity, and more competitive operations.

The survey results reflect the complexity, with most respondents supporting the use of Alternative Methods, with only a few against. The great similarities in the views on the reliability of both lockout and Alternative Methods show that each approach can be reliable when executed effectively.

Some respondents indicated that their older systems have so many energy isolation devices that implementing only LOTO was not feasible; the implication being that Alternative Methods are necessary to simplify hazardous energy control for their legacy machinery.

Bypassing safety systems

The responses to Question 15 indicate that safety systems are bypassed or defeated (32%) with only 11% indicated this occurs only *Rarely* or *Never*. This result is significant in that many serious injuries occur when safety systems are bypassed or defeated.

Chinniah (2015) shares the following concerning the bypassing of safety devices:

> The literature shows that the practice of defeating safety devices is quite wide spread. A study carried out by the IFA in Germany revealed that approximately 37% of all protective devices on metalworking machines were bypassed (Apfeld, 2010). Moreover, in Germany, 14% of machinery had their protective equipment permanently defeated, 23% of machinery had their protective equipment temporarily defeated and 34% of companies were affected by this problem. Approximately 25% of accidents linked to machinery in Germany were due to defeated protective devices. … *The study also revealed that protective devices which did not hinder the working process were not generally defeated as no benefit existed from doing so.* If unsuitable protective devices were used, the probability of them being bypassed was high. The defeated safety devices were not usually restored. If certain tasks such as setup were not considered during the design, bypassing would be unavoidable as it would not otherwise be possible to operate the machinery. Moreover, the CE mark on machinery did not mean that the safety devices would not be bypassed. (*italics emphasis added*)

In general, bypassing has been known to occur in the following conditions:

- The complexity of the system makes troubleshooting difficult.
- The system incorrectly senses a condition and inhibits operation.
- A sensor or device detects a false positive at a high error rate.
- System significantly impedes operations.
- LOTO impedes the task (e.g., power is needed).

In Question 15, 23% of respondents indicated that they *Don't know* if safety systems are bypassed or defeated. This result makes sense as the practice is probably not widely announced. Maintenance would very likely just execute the bypass quietly. Often bypasses are not necessarily easily identified (for example, a switch jumpered inside an electrical panel).

In Question 16, 18% of respondents indicated that they disable or override equipment safety systems to maintain compliance with OSHA requirements. This is another indication that bypassing occurs in industry, potentially putting workers at risk of harm.

Documentation Burden

The responses to Question 17 indicate that only 8% of the respondents had Alternative Methods without any documented risk assessment or supportive documentation, whereas 75% indicated they had some level of supporting documentation. These results are significant because OSHA and others have

expressed concerns about the documentation burdens that might be imposed if the rules were to allow the use of Alternative Methods. The results indicate that documentation is already occurring in industry, which suggests the actual administrative burden may be less than perceived.

Adoption of ANSI Z244.1

Questions 18 and 19 focused on whether OSHA should adopt the ANSI Z244.1 standard and the incorporation of risk assessment and the hazard control hierarchy in determining the methodology for controlling hazardous energy. In both questions, the majority of respondents (72% and 80%) agreed that OSHA should adopt ANSI Z244.1 and incorporate risk assessment and the hazard control hierarchy for controlling hazardous energy. Only 9% and 7% disagreed.

These results indicate a strong suggestion that the methods developed in industry to control hazardous energy using the risk assessment process should be adopted by OSHA. The respondents did not indicate that some other approach or type of analysis is needed. Whether OSHA adopts the requirements of ANSI Z244.1, or develops new requirements based on the standard remains to be seen. In any event, the message from this survey is that OSHA should strongly consider the approach used in ANSI Z244.1.

Minor Servicing Exception

The results of Question 20 on the Minor Servicing Exception are another indication of the need for Alternative Methods in industry. The respondents that found the Minor Servicing Exception very useful and allowing the ability to not lock out equipment, is an indication that LOTO is not well suited to all tasks and that some tasks require the ability to use Alternative Methods. In addition, nearly half of the respondents (47%) found that utilizing the Minor Servicing Exception to use an Alternative Method was not a favorable approach.

Question 21 addressed the ability of employers to determine which protective measure to apply. 75% of respondents agreed with this approach, while only 9% disagreed. These results strongly indicate the need for performance language in any rule that allows an employer the flexibility to determine the most appropriate solution for its situation. The respondents did not support a more prescriptive approach.

If OSHA were to explicitly allow the use of Alternative Methods, the Minor Servicing Exception becomes irrelevant and no longer needed.

Costs

Responses to Question 22 on the overall costs of ownership reflect various views on the topic. While it is true that the cost of safety devices is considerably higher than the cost of a lock and key, that alone does not accurately reflect the overall cost of ownership and overall equipment effectiveness which includes ongoing costs. One respondent specifically noted that the overall cost of ownership under “LOTO only” would greatly increase. The negative cost impacts on productivity are usually not calculated, and may not be given proper consideration in the overall cost-benefit equation.

Costs are part of the calculus that goes into the purchase of new systems versus continuing operations on legacy systems. Often the benefits of new machinery, equipment and processes come from higher uptime,

faster changeovers and jam recovery, and other aspects that depend on functional safety, control systems, and Alternative Methods.

This is a topic that lends itself to a quantified analysis using advanced methodologies developed for this purpose (see for example *Total Costs of Ownership* (2020). The majority of respondents indicated significant impacts to production, suggesting costs would greatly increase if Alternative Methods were no longer allowed. The quantification of the differences remains an area for further analysis.

OSHA Constraints

OSHA has constraints on what it can do in developing new rules. There is a nine step process OSHA must work through as part of promulgating a rule. The process is neither simple nor quick, and requires considerable supporting analyses. OSHA must also balance the views of different stakeholders in developing new rules (employees, employers, small to large companies, unions, politicians, enforcement, etc.). The 'correct' answer of which solution is technically better as to LOTO or Alternative Methods is a significant consideration, but not the only consideration.

Potential Solutions

The outdated requirements in 29 CFR 1910.147 create challenges for both OSHA and employers attempting to follow the requirements. Industry needs to be able to use Alternative Methods in lieu of lockout where appropriate. Currently many applications of Alternative Methods exist that successfully control potentially hazardous energy without lockout/tagout. OSHA is moving to update its requirements to help keep workers safe and protected.

The use of Alternative Methods should be limited to those that are appropriately designed, installed, used, and maintained to be commensurate with the risk. Not all Alternative Methods provide an adequate level of protection to be used in lieu of lockout/tagout.

With the publication of ANSI Z244.1 (2024), employers and equipment suppliers will have an improved process to provide Alternative Methods that provide effective protection in lieu of lockout/ tagout in certain applications.

The rules for the control of hazardous energy need to provide flexibility to companies to evaluate the best methods to use for their applications.

As shown in this survey, Alternative Methods are currently and widely being used in industry. OSHA and industry should work together to improve worker safety in controlling hazardous energy consistent with ANSI Z244.1 and the results of this survey.

Conclusions

The results of this survey shed light on several aspects of the control of hazardous energy and the current implications for industry. As expected, the results provide only an enhanced understanding, rather than an absolute clear path forward because there are many different views on the control of hazardous energy and Alternative Methods.

Skepticism of Alternative Methods does appear in the survey results, particularly due to the lack of confidence in the reliability of control systems. Without supporting analyses, one cannot say that this skepticism is misplaced. However, with proper design and analysis of control systems and functional safety, a high level of confidence can be placed for Alternative Methods.

As clearly shown in this survey, Alternative Methods are currently included in systems and are already being used throughout industry to keep workers safe from harm. The issue is not *if* Alternative Methods should be allowed. That ship has sailed. The real issue is *how* to ensure that the Alternative Methods are appropriate for the risk. Currently, ANSI Z244.1 provides the best means and methods to make this determination.

The issue is not digital – either LOTO or Alternative Methods. Both are needed. There are many tasks where LOTO is the appropriate and necessary means to keep workers safe from harm. Certain tasks require locking out the energy sources. There are also tasks that can be safely and effectively performed by relying on an appropriate Alternative Method. The survey results support the tenet that effective risk reduction is rarely just one solution, but typically several, and will often include both Alternative Methods and LOTO.

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