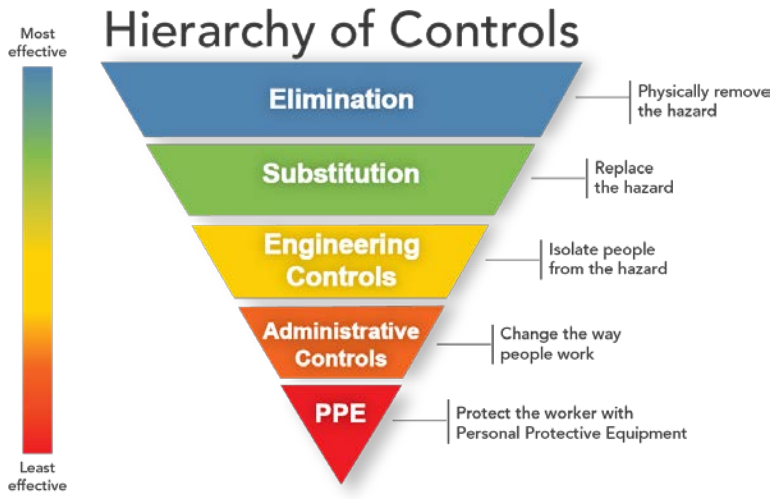
Seat Belt Use on Mobile Equipment

Issue

Most modern mobile equipment having a seated operator station is provided with some form of a protective structure, e.g. Roll-over Protective Structure (ROPS) or Tip-over Protective Structure (TOPS), and some form of operator restraint, such as a seat belt. The terms "operator restraint" and "seat belt" are used interchangeably in this paper. The combination of a protective structure and a seat belt comprises a safety system by providing the operator with a "safe zone" in the event of a rollover or tip over. Operators are more likely to survive and have less severe injuries from rollover or tip over accidents when they remain properly restrained by the seat belt. Many instances of survivable accidents have resulted in death or serious injury when operators are thrown or jump from the "safe zone" of the protective structure.

There have been repeated attempts to make operators aware of the importance of wearing seat belts during operation. Warnings are provided in the form of safety signs at the operator station, notifications and warnings in operator manuals, during operator training and specific promotions such as "Hard Hat Talks," "Safety Targets Program," "Tool Box Talks," and others. Often these programs are punctuated by hardhat decals, posters, best practice documents, and other safety awareness promotional items.

The National Institute for Occupational Safety and Health (NIOSH) Hierarchy of Controls program presents (as seen below) protections that remove or control exposures to occupational hazards. Many best awareness efforts in the past have focused on the bottom portion of this hierarchy. Despite these repeated efforts, a certain percentage of operators continue to refuse to wear a seat belt. This white paper will identify effective practices each stakeholder should consider to effectively assure the use of seat belts for the remaining class of equipment operators who continue to operate machines without the use of a seat belt.



Source: National Institute for Occupational Safety and Health

The goal of all stakeholders involved in the development of this white paper is to increase seat belt usage among equipment operators to help achieve the objective of "ZERO INJURY, ZERO HARM."

Potential Solutions

The use of seat belts as a protection against occupational hazards can generally be applied in two potential solution categories within the Hierarchy of Controls program: engineering and administrative controls. Engineering controls are designed to minimize the impact of hazards that are not or cannot be eliminated or substituted. For mobile equipment, engineering controls can take the form of active control interlocks such as preventing or stopping machine operation until a designated action is taken by the operator. Administrative controls promote the use of seatbelts by influencing the behavior of the equipment operator or management and require action by at least one individual. Administrative controls include passive warning devices, training, education, regulations, policies and procedures, which are all meant to influence behavior.

Engineering Controls

Active control interlocks are an engineering control that includes any system that prevents or affects machine operation in the event the seat belt is not properly fastened. This can also include requiring the operator to be present in order to start the machine. (E.g. seat switch). This type of system could be configured to log unsuccessful attempts to move the machine without engaging the seat belt, which subsequently could be used to identify areas of opportunity for management to promote seat belt use.

Advantages

- These devices are integrated with machine operation which may make them more difficult to defeat than passive warning devices.
- These devices are highly effective because they require operators to wear seat belts as part of the routine machine operation.
- The operator is required to fasten the seat belt, so these systems positively influence behavioral change of the operator.
- Sustainable solution over the long term requiring minimal administrative oversight.
- Has the potential to be highly effective if implemented properly.

Disadvantages

- Machine control could be affected in the event of active interlock system failure and may encourage a bypass to accommodate failure.
- Intentional disablement or misuse can result in unforeseeable operational consequences.
- Level of design complexity, engineering challenge and associated risk must be thoroughly understood in order to prevent potential negative safety ramifications.
- It may be difficult or impractical to install active control interlocks to existing machines.

Administrative Controls

There is a broad range of administrative controls that may be used to influence behavior to promote seat belt use, including passive warning devices, training, education, regulations, policies and procedures. Requirements for seat belt use have been established through individual site requirements and governmental regulations, and have also been addressed through the development of national and international design standards. Training operators to understand and comply with these requirements has been the main behavioral approach used to date.

These requirements are communicated in a variety of ways including:

- Original Equipment Manufacturer (OEM) operator manual
- Safety warnings affixed to the machinery
- OEM operator training
- Specific promotions such as "Hard Hat Talks" or other “Safety Targets Programs”
- “Best Practices” publications
- MSHA “Fatalgrams”
- OSHA Reports on workplace fatalities (https://www.osha.gov/Publications/fatalfacts.html)
- Union and user-group publications and training

When considering the behavioral aspects in the workplace, there are several stakeholders involved, including: The original equipment manufacturer (OEM), equipment dealer, machine operator, operator unions, training organizations, worksite management, and rule makers/regulatory agencies. Each stakeholder can take specific actions that will assist in improving the safety of the equipment operator.

Advantages

- Training is easy to understand and implement
- Training has been effective for a large percentage of equipment operators
- Regulations, worksite conditions of employment, and policies historically have been effective when enforced
- Clearly defined and enforced policies can create sustainable behavioral changes
- Positive reinforcement can positively influence long-term behavioral changes
- Potential carryover effect to similar benefits achieved when operating personal, private vehicles off site
- Workplace rules require minimal resources to develop and implement.

Disadvantages

- Training alone has been ineffective for the population of equipment operators that refuse to wear seat belts
- Workplace rules are a form of negative reinforcement that may not be welcomed by some operators and worksite management
- Workplace rules and worksite conditions of employment must be **constantly** and **consistently** enforced and reinforced
- Current seat belt systems have limitations in their ability to identify or influence behaviors

Machine - Passive Warning Devices (Operator)

Passive warning devices include warning lights and audible warning devices that remind the operator to fasten the seat belt prior to operation or that the seat belt is not fastened during operation. This classification is limited to operator station devices that warn the operator with no management notification. Varying levels of aggressiveness regarding the "annoyance levels" can be used. The levels could range from a timed flashing seat belt symbol on the instrumental panel to an audible alarm that expires either after a designated period of time or until the seat belt is fastened.

Advantages

- Annoyance factor can be effective in getting people to fasten their seat belt
- No action required by the operator other than to fasten the seat belt
- Similar to an existing and accepted approach implemented in the automotive industry
- Failure of the mechanism does not affect the control of the machine
- Reliable due to the simple nature of the installation
- Potential simplicity and ease of implementation for the OEM

Disadvantages

- The annoyance factor can result in disabling or bypassing.
- Depending upon their complexity, these systems can be rendered ineffective due to:
    - Ignoring: Passive warning devices can be ignored by the operator
    - Intentional Disabling: Warning lights and audible warning "buzzers" located in the operator station can be defeated with simple methods
    - Intentional Misuse: Some seat belt warning systems can be relatively easy to circumvent, e.g. buckling the belt behind the seat or operator
    - A simple failure in the mechanism (e.g., a bad light bulb) could render this safety system ineffective
- Current seat belt warning systems may have limitations in their ability to influence behaviors.

<u>Machine - Passive Warning Devices (Worksite Management)</u>

There are several types of passive warning devices that can indicate to worksite management whether an equipment operator is wearing a seat belt. Warning devices such as an external light on the operator's cab or brightly colored seat belts are examples of passive warning devices that can indicate to worksite management that the operator is not restrained with the seat belt. More advanced passive systems can provide a direct telematics link to notify worksite management. To be effective, systems that remotely indicate the status of seat belt use require the full support of all stakeholders, including worksite management, operator unions, and, possibly, regulatory authorities. Such solutions need to be part of a larger plan involving operator training and worksite management authority to realize the full benefit of, and act upon, the notifications. Devices which alert management depend on the willingness of worksite management to use this information to encourage and enforce seat belt use.

Worksite management can collect performance data on a group basis to be used as a metric determining the level of compliance to formal policies or goals. Those compliance metrics then can be used to trigger incentives for compliance, such as safety incentives or other benefits. The incentive can be part of a larger plan involving operator training and worksite management authority to enforce seat belt usage.

Advantages

- Can be very simple to implement
- Reliable due to simple installation
- No action required of the operator other than to fasten the seat belt
- Flexibility to communicate seat belt status to worksite management
- Ability for worksite management to implement incentives and/or consequences
- Developing group-based metrics creates a sense of community that can leverage peer pressure to encourage compliance
- Incentive programs have proven effective in a number of industries and situations

Disadvantages

- Some systems, such as those that use brightly colored seat belt webbing, would require greater care to maintain their effectiveness
- Systems that notify worksite management are dependent upon management involvement
- There could be a motivation to falsely report non-compliance
- There could be a question as to the actual metrics, should significant financial incentives be used
- Discontinuation of incentives can lead to negative reactions
- Notification systems may not be universally effective for all machines
    - Lack of visibility
    - Conflicting lighting requirements
    - Lack of existing telemetry
- Could be defeated

Stakeholder Roles

The roles played by each stakeholder are addressed below:

Original Equipment Manufacturer (OEM)

- The OEM is responsible for the design, testing, manufacturing and delivery of a quality product to the market
- OEMs apply voluntary consensus standards and best practices to equipment design to produce safe and efficient products capable of performing the intended task
- Instructional materials, such as safety signs and manual sets, are developed and supplied by the OEM as part of the original machine purchase

Equipment Dealer

- Equipment Dealers, in many cases, serve as the conduit between the OEM and the machine owner/operator providing:
    - Pre-delivery checks, final setups and physical delivery of equipment
    - Operator training on the product at time of delivery
- Dealers assist in the long-term maintenance of products and provide an interface between the OEM and the equipment owner

Machine Operator

- The machine operator is ultimately responsible for the proper use of the seat belt.

Worksite Management

- Worksite management is responsible for considering the site specific factors relevant to seat belt use. This includes evaluating controls (both active and passive) that may be suitable for modifying in-service equipment, researching controls that will be effective on future equipment purchases, evaluating the workforce so that the seat belt program can be tailored to their needs, and establishing and enforcing job site policies that communicate clear expectations.

- Policies, procedures and programs can improve seat belt use via:
    - The development and enforcement of consistent, well-documented policies and procedures. These could include conditions of employment and clearly communicated means of enforcement.
    - Orientation programs that train equipment operators on the expectations for seat belt use.
    - Policies that include the use of positive reinforcement, such as safety challenges.
    - Some employers establish seat belt usage as a condition of employment. This is an effective element of a seat belt program that can be improved by the establishment of industry-wide seat belt regulations.
- Cultural influences and demographics to consider when establishing a seat belt program:
    - Age/generation
    - Worker type
    - Individual conditioning
    - Risk tolerance
    - Training levels
    - Traditions

Rule Makers/Regulatory Agencies

- Regulators hold management accountable when employees do not comply with regulations. The establishment of industry-wide seat belt regulations may create a culture of zero-tolerance for failure to wear seat belts; which can support efforts to increase seat belt use.
- Industry-wide seat belt regulations may convince operators of the need to use seat belts, as some operators do not accept personal responsibility for their own safety.

Other Considerations

While modern equipment is sold with appropriate operator restraints, maintenance of those restraints is little understood. Routine inspection of webbing, retraction devices, and latches should occur in accordance with manufacturer's recommended schedule. Any obvious damage or degradation of the restraint should be corrected immediately.

Seat belt type is a factor that can promote the use of seat belts. Improper application of automatic locking retractors can cause operator discomfort, and therefore, discourage seat belt usage.

Automotive and Aviation Industry Experiences

<u>Automotive</u>

The automotive industry initially installed lap belts and then moved to lap and shoulder harnesses. At one point the industry integrated passive "automated supplemental restraint systems" (including motorized shoulder harnesses that positioned the shoulder harness once the vehicle was started) and

door mounted seat belt that positioned the seat belt upon closing the door. These integrated solutions have been abandoned for a passive warning approach, with varying degrees of duration and annoyance, to remind the operator to use seat belts. More recently, one manufacturer is reconsidering active control interlocks[1], [2].

Regulations and their enforcement appear to have caused a marked increase in seat belt use. Regulatory requirements for seat belt use have been implemented in most states, which work in conjunction with machine-installed passive and active seat belt use systems. Automobile drivers are personally responsible for their own well-being and that of their passengers. Enforcement has proven to be an effective motivator to wear seat belts; states implementing regulations have increased seat belt usage, in some instances from the mid 30% levels to the high 80% levels. According to the National Safety Council, the national average of seat belt use is at 88%, and seat belt use is 11% higher in states with primary enforcement laws than in states with secondary enforcement only.[3]

Aviation

Commercial airline passengers are familiar with the experience of watching a safety demonstration of the "safety features of this Aircraft." During these brief pre-flight demonstrations, passengers are shown the proper way to fasten, tighten, and release the seat belts. Passengers are also instructed to remain in their seats with their seat belts fastened throughout the flight and specifically while the "Fasten Seat Belt" light is illuminated. Often, on long flights, passengers are instructed to fasten their seat belt over any blankets so that the latches are visible to flight attendants should the passenger be asleep. While there are no engineering controls used, the administrative controls common in this industry are lights throughout the cabin to indicate that seat belts should be fastened and consistent management involvement, including visual confirmation of seat belt engagement during critical times of the flight. This strong involvement is done to assure compliance with the existing regulatory requirements for both crew and passengers:

- 14 CFR §91.105 requires "Keep the safety belt fastened while at the crewmember station."[4]
- 14 CFR §91.107 Requires "…each person on board a U.S.-registered civil aircraft …must occupy an approved seat or berth with a safety belt and, if installed, shoulder harness, properly secured about him or her during movement on the surface, takeoff, and landing…."

Recommended Best Practices

The existing efforts by all stakeholders to train equipment operators and to promote seat belt usage should be continued. The safest place for equipment operators to be during an accident is in the "safe zone" of the protective structure. Yet there is a small percentage of persons who simply choose not to

[1] http://media.gm.com/media/us/en/gm/news.detail.html/content/Pages/news/us/en/2014/May/0519-buckle-up.html
[2] http://www.autoblog.com/2014/05/21/optional-gm-system-wont-drive-without-seatbelt-official-poll/
[3] National Safety Council, Injury Facts 2014 Edition
[4] http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=3efaad1b0a259d4e48f1150a34d1aa77&rgn=div5&view=text&node=14:2.0.1.3.10&idno=14#se14.2.91_1105

wear seat belts. Further action is required to overcome the objections of those who do not wear their seat belts and to achieve the stated goal of "ZERO INJURY, ZERO HARM."

Each stakeholder plays a vital role in implementing the Hierarchy of Controls methodology to promote the proper use of seat belts. Each stakeholder needs to consider the appropriate solutions, within the overall Hierarchy to help ensure proper seat belt usage.

The following is a list of best practices for each stakeholder to consider.

Equipment Dealer:

- Should provide equipment-appropriate training regarding:
    - Seat belt use
    - The requirements for routine seat belt maintenance in accordance with OEM recommendations
- Should notify equipment owners of new OEM packages that promote seat belt use.

Machine Operator:

- Equipment operators make the ultimate decision concerning the use of the seat belts and need to take personal responsibility and utilize seat belts when they operate a piece of equipment.

Machine Operator Organizations, such as unions or training organizations:

- Through training and policy, continue to encourage safe working practices including the use of seat belts when operating equipment.

Machine Owner:

- Maintain the machine and all of its systems in good working condition.

Original Equipment Manufacturer (OEM):

- OEMs should evaluate each machine type to determine the most appropriate strategy that encourages seat belt use and implement the most appropriate solutions, including:
    - Passive warning devices with operator reminders and optional remote-notification mechanism
    - Active control interlocks with optional remote notification-mechanism
- When an operator restraint strategy is defined and deemed appropriate for new products, OEMs should consider developing kits which could be installed on existing products

Rule Makers/Regulatory Agencies:

- Rule makers and regulatory agencies should consider requirements for assuring seat belt use, when so equipped, for all equipment operators
- Regulatory agencies must assure that worksite management is complying with regulations and take action to assure that equipment operators also comply.

- Rules and regulations for seat belt use need to be enforced at the job site management and operator level

Worksite Management:

- Should consider implementing and enforcing a "condition of employment" seat belt policy
- Should reinforce seat belt use via:
    - Orientation programs setting the expectations of seat belt use
    - Operator training
    - Implementing meaningful incentives for seat belt use.
- Should consider the use of remote-notification options, including:
    - Purchase of Optional remote-notification mechanisms for new equipment to notify both the surrounding operators and worksite management concerning proper use of the seat belt
    - Retrofit notification products, such as brightly colored seat belts or strobe lights, for installation on existing products
- Should consider the use of OEM authorized engineering controls to promote seat belt use

This white paper has been developed by and represents the thoughts of the following stakeholders:

Association of Equipment Manufacturers (AEM)
Mine Safety and Health Administration (MSHA)