

Workplace Safety & Health Guidelines

Safeguarding Against Falling Objects



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1. Introduction

Struck by falling objects (SBFO) is statistically the second most common cause of workplace fatalities in Singapore. Furthermore, SBFO is a common hazard across all industry sectors and had resulted in many cases of workplace injury. Members of the public may also be at risk from SBFO if workplace safety is not managed well.

Management has a key role in preventing SBFO incidents from occurring, and must take the lead in Workplace Safety and Health (WSH) efforts. This is important for developing a good safety culture where each individual takes personal responsibility for safety and health at the workplace.

This set of guidelines focuses on the dangers of items that fall from height. Falling objects can strike persons on the head and the resultant injuries can be fatal. Therefore, it is imperative that reasonably practicable efforts are taken to prevent objects from falling onto persons. Protection provided by personal protective equipment (PPE), such as helmets, may sometimes be unable to effectively safeguard a person who is struck by falling objects.

These guidelines are intended to provide information and guidance on situations where SBFO is a hazard and the preventive measures that can be taken to safeguard people who work on the site, visitors to the site and members of the public.

2. Risk Assessment

Risk Assessment/ Risk Management

The risk assessment process helps to identify and prevent hazards at the workplace. It also helps in the implementation of effective risk control measures before risks escalate into accidents and injuries.

Under the WSH (Risk Management) Regulations, every workplace, including factories, should conduct risk assessments for all routine and non-routine works.

It is the process of:

- Identifying and analysing safety and health hazards associated with work;
- Assessing the risks involved; and
- Prioritising measures to control the hazards and reduce the risks.

Before conducting risk assessment, adequate preparation must be done. A risk assessment team should be formed, preferably consisting of personnel from various levels in the work activity. Relevant information should be collated to facilitate better understanding of the work process.

After completing the preparation work, workplace risks can then be assessed in three simple steps.

STEP 1: Hazard Identification

Hazard identification involves identifying hazards associated with the activity of each process and potential accidents or ill health that could result from these hazards. It also identifies the person(s) who may be at risk as a result of being exposed to these hazards.

STEP 2: Risk Evaluation

Risk evaluation is the process of estimating the risk levels of the hazards and their acceptability. This is used as a base for prioritising actions to control the hazards to minimise safety and health risks.

Risk evaluation is made up of two parts:

- Estimating the severity of the hazard; and
- Estimating the likelihood of the incident or ill-health occurring with the existing risk controls.

STEP 3: Risk Control

Based on the risk evaluation in STEP 2, risk controls should be selected to reduce or confine the identified risk to an acceptable level.

These risk controls must be effective yet practicable. To control hazards and reduce risks, the control measures below should be considered in the following order:

- Elimination;
- Substitution;
- Engineering controls;
- Administrative controls; and
- PPE.

See Page 8 for a Sample Risk Assessment. For more information, please refer to Guidelines on Risk Assessment at www.mom.gov.sg

Risk assessment, when carried out appropriately, would allow a better understanding of risks at the workplace and their control measures. It is a key component of risk management. Besides risk assessment, good risk management also consists of other components such as communication, record keeping, and implementation and review. Together, they form the risk management process captured in Figure 1.

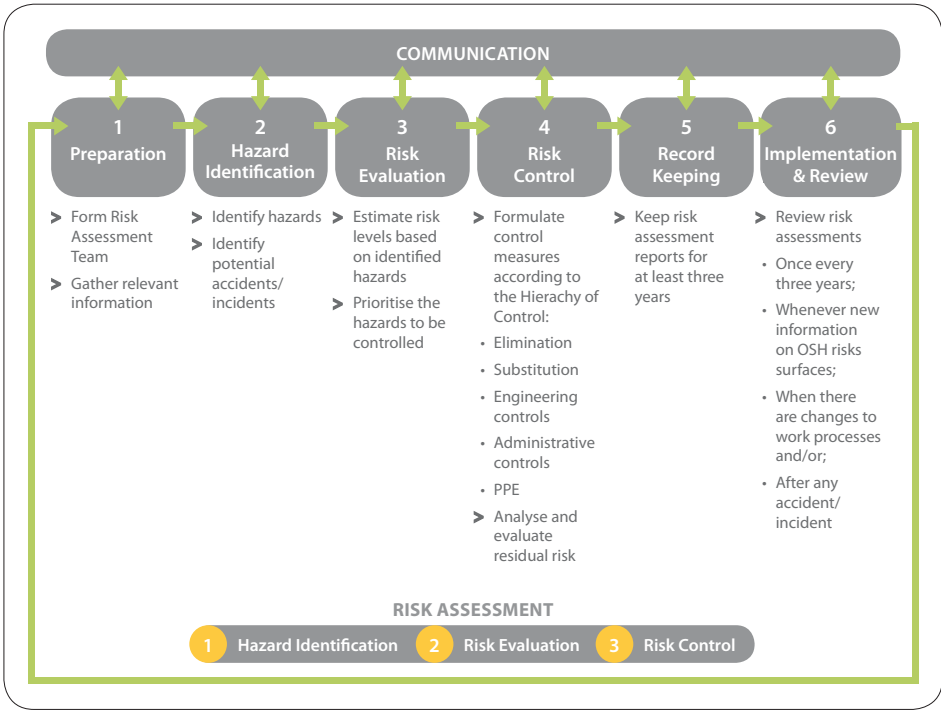


Figure 1: Flow chart of the risk management process.

3. Hierarchy of Control

The selection of control measures for hazards and reduction of risks can be accomplished by following the Hierarchy of Control (see Figure 2).

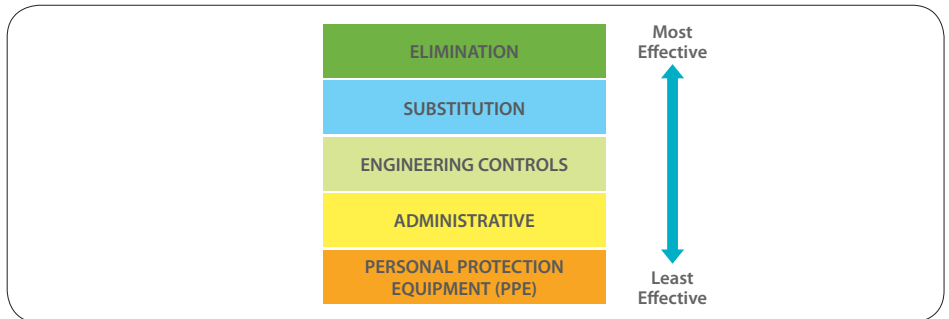


Figure 2: **Hierarchy of Control.**

In considering each measure in the Hierarchy of Control (Figure 2), the following elements of what is reasonably practicable must be considered:

- The likelihood of a hazard or risk occurring (i.e., the probability of a person being exposed to harm);
- The degree of harm if the hazard or risk occurs (i.e., the potential seriousness of injury or harm);
- The person's degree of understanding on the hazard or risk, and any possible ways of eliminating or reducing the hazard or risk; and
- The availability and suitability of ways to eliminate or reduce the hazard or risk.

Control measures are not usually mutually exclusive. It may be necessary to use more than one of these measures to reduce a risk to its lowest possible level when no single measure is sufficient on its own. For example, engineering controls can be implemented together with administrative controls like training and safe work procedures.

Elimination

Elimination of hazards refers to the total removal of the hazards and hence effectively eliminating the possible occurrence of incidents and ill health. This would be the permanent solution and should be attempted in the first instance. When a hazard is eliminated, the associated risks cease to exist as a result.

For example, air conditioner compressors can be installed near ground level, where possible. This eliminates the need to work from height, and in doing so, eliminates the risk of falls from height and being struck by fallen tools or even the compressor itself. Maintenance work will also benefit from this, in addition to the initial installation work.



Figure 3: Air-conditioning compressor units installed at ground level eliminates the need for work at height and the risk of being struck by falling objects.

Substitution

This involves replacing a hazard with one that presents a lower risk.

It is possible to consider the usage of prefabricated or precast materials that can be assembled easily. With this approach, prefabricated components such as precast façade components are produced in the factory which has a safe and cleaner working environment, before they are delivered and assembled on site. This minimises the time workers need to conduct work at height which, in turn, minimises the risks of falling objects and being struck by falling objects. This is in contrast to the conventional way of using in situ casting that require workers to work at height for extended periods of time for the messy formwork erection, rebar installation, concreting and plastering works.

Engineering Controls

Engineering controls are physical means that limit the hazard. These include structural changes to the work environment or work processes by erecting a barrier to interrupt the transmission path between the worker and the hazard.

By intercepting the path of falling objects, engineering controls such as safety nets and catch platforms prevent objects from striking persons below. However, they must be of sufficient strength to withstand the force generated by the falling object.

Administrative Controls

These reduce or eliminate exposure to a hazard by adherence to procedures or instructions. Documentation should emphasise all the steps to be taken and the controls to be used in carrying out the activity safely.

After risk assessment has been carried out, Safe Work Procedures (SWPs) should be implemented to manage safety and health risks. SWPs should include emergency plans in addition to safety precautions. It should also reiterate the importance of proper usage of PPE.

SWPs and good planning can mitigate risks of potential SBFO incidents. However, supervision and enforcement would be needed to ensure the effectiveness of administrative control measures. Administrative controls can also include signs and warnings to inform or remind workers.



Figure 4: Signs can be used to warn persons at work if there is a risk of falling objects and that safety helmets are needed.



Figure 5: If safety helmets cannot provide enough protection, consider prohibiting access to the area. A “no entry” sign can accompany this sign to ensure nobody enters the area.

Training can include methods and aspects, such as good housekeeping practices and organisation and storage of materials, that can help prevent falling objects.

PPE

The proper use of PPE can help to keep workers safe at work. However, PPE should only be used in addition to other forms of control measures (e.g., engineering control measures) or when these other measures are not feasible or practical.

When used in isolation, PPE can only provide a marginal degree of protection, usually only adequate for protection against light falling objects. However, PPE can be used as a supplement to other risk control methods, where they can provide an additional layer of protection.

Residual Risks

Residual risks are the remaining risks following the implementation of risk controls. The risk assessment team should ensure that residual risks are acceptable and manageable.

4. Sample Risk Assessment

RISK ASSESSMENT FORM									
Company:		ABC Warehousing Pte Ltd		Conducted by: (Names, designations)		Mr DEF, Warehouse Supervisor			
Process/ Location:		Goods storage area							
Approved by: (Name, designation)		Mr GHI, General Manager		Conducted on: Last Review Date:		Approved on: Next Review Date:			

No	Work Activity	Hazards	Possible Accidents/ Ill Health and Persons-at-Risk	Existing Risk Control (if any)	Likelihood	Severity	Risk Level	Additional Risk Controls	Action Officer, Designation (Date)
1	Transfer of metal pipes using overhead travelling crane	Struck by falling load	Injury or death to persons struck	Use of tag lines to control load sway/ swing Barricades and signs to keep non-essential personnel from entering the affected area Crane alarm is switched on during movement	Unlikely	Catastrophic	Medium	Nil	Supervisor (immediate)
		Struck by falling lifting gear	Injury or death to persons struck	Barricades and signs to keep non-essential personnel from entering the affected area Crane alarm is switched on during movement	Unlikely	Catastrophic	Medium	Nil	Supervisor (immediate)
		Struck by falling objects (materials, tools, fittings such as brackets, screws.)	Injury or death to persons struck	Wearing of helmet within work area Warning signs placed (wearing of helmet, no entry to unauthorised persons)	Possible	Catastrophic	High	Work area cordoned off with barricades Tools and materials kept in boxes and bags when not in use	Supervisor (immediate)
2.	Installation of new racks								

Likelihood Severity	Likelihood				
	Rare	Unlikely	Possible	Likely	Almost Certain
Catastrophic	Medium	Medium	High	High	High
Major	Medium	Medium	Medium	High	High
Moderate	Low	Medium	Medium	Medium	High
Minor	Low	Medium	Medium	Medium	Medium
Negligible	Low	Low	Low	Medium	Medium

5. Storage of Items

Storage of loose items on racks or shelves can be hazardous. The loose items may be dislodged during the intentional removal or from unintentional bumping against the racks or shelves. The safe maximum load of shelving or racks should be strictly adhered to at all times.

Storage of heavier items on lower racks of shelves

For storage racks or shelves, heavier items should be placed lower down and lighter objects can be placed on the higher levels. This will give additional stability to the rack, and reduce the risk of toppling racks. Additionally, lighter objects pose a potentially lower chance of severe head injuries in the event that items stored on higher levels get displaced from position.

Securing items for safe storage

Methods of securing goods/ items, to keep them in place, during storage:

- Netting
- Restraining bars

Small, loose items can be tied together, wrapped or kept in containers to prevent unwanted movement and falling.

Provision for safe storage of irregularly shaped items should be provided.

Boxes and bags can help prevent unwanted movement of rounded or spherical items.



Figure 6: Heavier objects should be stored on the lower shelves for stability and safety.



Figure 7: Netting can help prevent the dislodging of stored items.

6. Working at Height

In addition to falls from height, work activities carried out at height can also result in dropped objects or materials.

Prevention of objects falling through openings on elevated work platforms

When work is carried out on elevated work platforms (e.g., scaffolds), measures must be taken to ensure the safety of workers below. Should there be a risk that items may fall (e.g., over toe-boards), panelling can be installed to prevent the fall of such items.

Overlay/ screening nets

Such nets are required by legislation [Factories (Scaffolds) Regulations] to be used to envelop scaffolds that are erected on the outside of a building. They will form a preventive layer to guard against the dislodging of equipment or materials.

Safety nets

Safety nets set up under elevated work areas can help prevent tools and materials from hitting workers who are below the work area should there be any accidental dislodging.

Catch platforms

A catch platform is a temporary structure located below a work area, meant to catch any fallen materials or tools. The platform must be constructed with sufficient strength, designed to withstand the maximum expected impact. The width of the platforms must also be large enough to effectively intercept the trajectory of falling items.



Figure 8: Overlay nets can prevent light objects from being accidentally thrown from the interior of the building.

Toe-boards for scaffolds and work platforms

Toe-boards are installed on all sides of the work platforms on the scaffolds, with the main purpose of preventing materials or tools on the surface of the platform from being unintentionally knocked off. Toe-boards are required under the Factories (Scaffolds) Regulations to be of good construction, sound material and adequate strength to withstand the impact during the course of work, with a minimal height of 90 mm. Refer to the Factories (Scaffolds) Regulations for more details on requirements for toe-boards.

Controlled lowering of materials or tools, as opposed to throwing

Controlled lowering of materials or tools is one of the more preferable methods of removing items or tools from elevations. It reduces the chances of worker or the general public been exposed to the hazard of being struck by objects being thrown about. Care must be taken to ensure that the load is secure and will not drop while it is being lowered.

Use of waste disposal/ debris chutes

Enclosed chutes can be used for the safe removal of unwanted materials quickly. The chute keeps debris within itself, preventing materials that are dropped from falling onto people.



Figure 9: Toe-boards prevent items from falling off the surface of the platform of the scaffold.

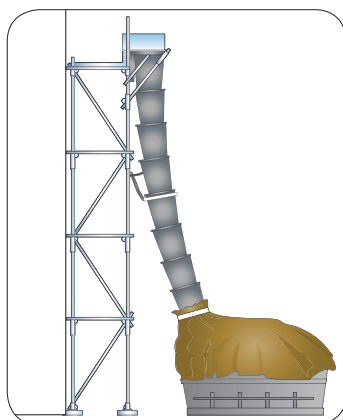


Figure 10: Waste disposal/ debris chutes prevent materials from accidentally falling onto people.

Tethers/ Tie-downs for tools

Tethers and tie-downs such as lanyards, straps, and slings can help prevent tools from being dropped should the worker drop the tools during transportation, lose his grip while using them or accidentally leave the tools behind after work. The tether should be secured and be made of a sufficiently durable material. If possible, such tethers should be specifically designed instead of being added onto existing tools so as to prevent any accidental detachment of the tethered tool and preserve the functionality of the tools.

Tool bags/ belts/ pouches

Using a bag, belt or pouch to hold tools can help prevent the accidental drop of tools or small materials during climbing or moving. This also helps prevent the worker from falling from height, as he can maintain three points of contact and have a better hold on the ladder.



Figure 11: Tools tethered to the user by means of a lanyard can prevent them from falling and striking persons below. It also prevents them from being left behind accidentally after work.



Figure 12: Using a tool bag, belt or pouch leaves the hands free for climbing the ladders. The worker can maintain three points of contact as well.

7. Safe Transfer of Materials or Goods

Activities involving the transfer or movement of materials can result in serious injury if not managed properly. For example, the load may be dislodged after striking an obstacle and fall onto persons nearby. Forklifts and overhead travelling cranes are two commonly used types of equipment for the transfer of materials.

Clearance

Ensure that personnel are kept away from the path of movement before starting the transfer. Ensure that there is sufficient clearance space around and above the intended path so that the materials do not strike nearby objects, structures or obstacles.

Stability of the load

Loads should be made as stable as possible before they are lifted and moved. This is to prevent any tipping or swinging of the load during transit. If necessary, they may also be secured to increase stability.

Hazards posed by the load

The nature of the load may pose hazards to persons within or around the work area. Loads that are overly bulky, very long, irregularly shaped or have off-centre centres-of-gravity need special consideration. The use of specialised attachments can allow forklifts to carry such loads safely. However, the attachments may reduce the carrying capacity or safe working load of the forklift, due to the shift in the centre-of-gravity of the entire forklift. Consult the manufacturer of the attachments to determine the required adjustments in safe working load.

General safety for travelling equipment

General safe work practices, such as only allowing trained and authorised operators to operate such equipment, keeping within the speed limit and the safe working load of the equipment are to be followed at all times. For more information on safe work practices for forklifts, travelling cranes, managing workplace traffic and so on, refer to the Workplace Safety and Health Guidelines on Workplace Traffic Safety Management on www.wshc.sg

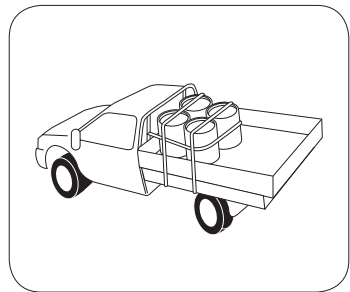


Figure 13: Strapping the drums prevents them from toppling during transit.

Securing of items during installation

For items that are moved into position by machinery for installation work, it is vital to ensure that the item is installed securely to the structure before disengaging the machinery or any slings or brackets that are holding the item in place.

8. Lifting

Lifting operations, if not managed properly, can result in heavy loads falling onto persons below. This is potentially the most severe type of SBFO due to the weight (e.g., I-beams) and/or quantities (e.g., bricks or tiles) of the dropped objects.

Lifting operations

- No entry areas



Figure 14: Signs can be used to warn persons of lifting works in progress, and prevent accidental entry.

Designate no-entry areas during lifting operations. This should be communicated to affected parties (e.g., those who are expected to be nearby). Supplement with barricades and signs or even “sentries” to prevent access into potential areas of impact.

- Scheduling
If possible, consider conducting lifting operations during times where fewer people are expected to be present.
- SWPs
Never lift, lower or swing a load over people. Be aware that the momentum of a load that is swung may cause it to travel outward from the centre of the swinging arc. Additionally, ensure that loads are secured and balanced before hoisting commences.

Lifting plan (includes SWP)

- Communication (lifting operations)
Engage only trained personnel in the lifting operation. Maintain clear and concise coordination between machine operator and co-workers.
- Designation of “no entry” areas
This is to prevent unauthorised personnel from getting near or entering the danger area when the lifting operations are in progress.

Maintenance for lifting appliance/ machine/ gear

To ensure serviceability and functionality of lifting appliance/ machine/ gear, scheduling routine repairs, maintenance work and inspection is essential. This would aid in the monitoring and prevention of premature equipment failure, thereby avoiding unnecessary injuries or accident and production downtime.

For more information on safety during lifting operations, refer to the Technical Advisory for Safe Operation of Lifting Equipment on www.wshc.sg The following Singapore Standards can be consulted for specific information for lifting operations:

- SS 536 : 2008 Code of practice for the safe use of mobile cranes
- SS 497 : 2002 Design, safe use and maintenance of overhead traveling cranes
- CP 35 : 1996 Code of practice for the selection, care and maintenance of steel wire ropes for hoisting
- SS 297 : 1996 Steel wire ropes for hoisting
- SS 343-1 : 2001 Lifting gear – wire rope slings
- SS 343-2 : 1989 Lifting gear – hooks
- SS 343-3 : 1990 Lifting gear – shackles
- CP 101 : 2004 Code of practice for safe use of powered counterbalanced forklifts
- CP 63 : 1996 (2005) Code of practice for Lifting of persons in work platforms suspended from cranes

The Code of Practice for Safe Lifting Operations in the Workplace is currently under development by the WSH Council.

9. General Safety Practices

Some good practices that can help reduce the risk of being SBFO are applicable in most situations. Good practices highlighted in previous portions of this guide can also pertain to general situations. For example, imposing no-entry areas with cordons or barricades and the use of signs can keep people from entering areas where SBFO may occur.

Overhead protection for pedestrians

Overhead protection structures (e.g., shelters) must meet certain standards. They should provide collective protection to all who are under it. Overhead protection should be structurally strong to prevent collapse or penetration due to objects that may fall onto them. Such structures can be erected to protect persons entering or leaving buildings that are under construction.

Overhead protection for machines

Some work activities can expose operators of industrial vehicles to the risk of being SBFO. This is especially so for vehicles used in earth moving or excavation works. Another example would be operators of vehicles involved in the felling of trees or the pruning of large branches from trees. Below are some examples of international standards which stipulate the requirements for such overhead protection:

- AS 2294.1-1997 Earth-moving machinery – Protective structures – General
- ISO 8083:2006 Machinery for forestry – Falling-object protective structures (FOPS) – Laboratory tests and performance requirements



Figure 15: Collective protection is achieved by use of an adequately robust overhead shelter.

Rusting or corrosion of metal objects

Metal objects that are installed at high altitudes should be periodically examined. Corrosion or rusting can result in structural weaknesses which can cause objects to fall without warning. Examples of such objects include bolts and nuts, hanging light fixtures.

Additionally, secondary retention (e.g., using wires, straps, chains or netting of sufficient strength, to provide a means of preventing an object from falling when it becomes detached) can help protect persons from being struck by falling objects.

Good housekeeping

Keep unused tools and materials in their respective toolbox or place. This prevents workers working nearby the overhead structure from accidentally kicking, throwing or sweeping the tools/ materials off. These tools/ materials may fall onto workers below.

Storage of materials or equipment should be done away from working edges. Loose items, such as mortar, scattered masonry, and all other materials and debris should be kept clear of the working area through removal at regular intervals.

No kicking, throwing or pushing any object off edges

Workers should be instructed never to kick, throw or push unwanted materials or items off edges. While signs can serve as a reminder to workers, supervision would be required to ensure that such unsafe practices are not carried out.

Training

Safety training for workers can include topics related to prevention of and protection from falling objects, for example:

- Nature of hazards relating to falling objects in the work area;
- The meaning/ reason behind no entry zones or hard hat zones
- How they may contribute to prevent SBFO incidents, for example:
 - Clearing away debris

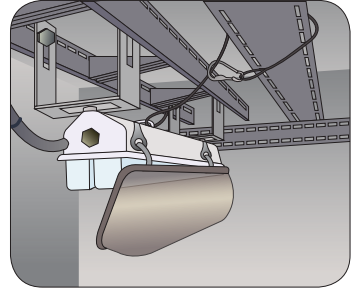


Figure 16: Secondary retention can prevent hanging objects from striking persons below if they fall.



Figure 17: Unsecured materials placed near edges may be knocked over accidentally.

- Keeping tools in designated areas, away from edges
- Not dropping or kicking unwanted items over the edge

Proper fitting and wearing of PPE

PPE that is used by workers to carry out work at height must be worn and fitted properly. PPE that is ill-fitting or not worn properly may drop off, and pose an SBFO risk to workers below.

Safety helmet

Safety helmets provide some protection for the head—it will protect the wearer against small, light objects, such as hand tools. It is insufficient to protect the wearer against heavier objects therefore, other methods of prevention and protection are needed. Helmets should conform to Singapore Standards SS 98 : 2005 – Specification for Industrial safety helmets. Helmets are also potential falling objects, hence chin straps are highly recommended for helmets worn for work at height.

Safety shoes/ boots

Safety shoes and boots provide limited protection for the feet against light objects dropped such as small tools or materials like nuts and bolts.

Provision of PPE for visitors

Visitors to areas where SBFO may occur should be provided with the appropriate PPE.

PPE that limit vision

Some PPE such as welding helmets or goggles limit a wearer's vision. As such, more attention or supervision may be required in areas where such PPE are used. The hampered vision may result in the worker being less able to spot tools or debris on the ground, or hazards above him.



Figure 18: Safety shoes and boots provide limited protection for the feet from light falling objects.



Figure 19: Consideration needs to be made for workers who are required to perform work using PPE that can obstruct or hamper their vision.

10. Acknowledgements

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