Workplace Safety and Health Guidelines

Working safely on roofs

WSHCOUNCIL

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Contents

1. Introduction

Working on roofs is a high-risk activity. From 2007 to 2011, fatal falls during work on roofs had claimed 20 lives. Fall from roofs have also caused serious workplace injuries, often resulting in permanent disabilities (e.g., paralysis). Hence this guide is developed to help contractors who are involved in roof works or required to perform work on roofs, better manage and prevent fall from heights while working on roofs.

1.1 What this Guide is about

This guide is relevant for new roof construction and work on roofs of existing buildings (e.g., inspection, repair, maintenance, cleaning work and demolition). It contains salient points on how to plan and work safely on roofs operations such as:

- key considerations in planning for work on roofs;
- fall hazards in various stages of work on roofs;
- control measures against falls;
- administrative controls; and
- personal protective equipment (PPE).

After reading this guide, the user should be able to:

- Identify the risks involved with working on roofs;
- Choose the right access equipment for use on the job;
- Understand and determine the appropriate measures for risk control; and
- Develop a plan to prevent falls during roof works.

1.2 Regulations and Other Guidance Documents

This guide should be read with reference to the following regulations and guides relevant to roof work safety:

- Workplace Safety and Health (WSH) Act
- WSH (Work at Heights) Regulations
- WSH (Scaffold) Regulations
- WSH (Risk Management) Regulations
- Code of Practice for Working Safely at Height
- Code of Practice for WSH Risk Management
- SS508 Part 4: 2008 - Specification for graphical symbols - Safety colours and safety signs - Design principles for graphical symbols for use in safety signs
- SS528 Part 1 to 6 : 2006 – Personal fall-arrest systems
- Singapore Standard SS 570 : 2011 – Specification for personal protective equipment for protection against falls from a height – Single point anchor devices and flexible horizontal lifeline systems

2. Planning for Safety

Work on roofs can occur in various scenarios such as new roof construction, installation of glass canopy roof for car porch, demolition, building operations or maintenance (e.g., replacing skylights for factory). Work on roofs may also be temporary or of short duration in natures, such as inspection of gutters, cable installation and maintenance of air-conditioners.

Regardless of a project's duration, whether it is short-term, such as replacing a few roof tiles of a house, or long term, such as major refurbishment of an existing property planning, it is vital to ensure safety while working at height on roofs. Planning by all parties involved helps to ensure that the work is carried out safely, efficiently and without undue delay.

2.1 Fall Prevention Plan

Under the Workplace Safety and Health (Work at Heights) Regulations 2013, the Fall Prevention Plan (FPP) is required to be implemented for workplaces listed in the Schedule of the said regulation. The Fall Prevention Plan (FPP) is an essential tool in the *Code of Practice for Working Safely at Heights* to help companies manage falling from heights hazard at work including work on roofs.

It is a site-specific plan that provides a systematic approach towards eliminating or reducing the risk of falling from heights by ensuring that all reasonable fall protection measures and methods have been taken prior to the commencement of work.

A comprehensive FPP for roof work should include (but not be limited to):

- policy for fall prevention;
- responsibilities;
- hazard identification and risk assessment (RA);
- control measures and methods;
- safe work procedures;
- personal fall prevention equipment;
- inspection and maintenance;
- training;
- incident investigations; and
- emergency response.

The FPP should be developed and implemented for all roof work activities. Refer to the *Code of Practice for Working Safely at Height* for more details on FPP. For more guidance on risk management (RM) and RA processes, refer to *Code of Practice for Risk Management*.

2.1.1 Identifying Fall Hazards Working on Roofs

Not all roof works are carried out as part of new construction projects. In many cases, most of the roof work (e.g., repair of air-conditioning unit) may involve work on existing buildings such as roof inspections, repairs, cleaning, cabling and non-roof maintenance activities.

It is therefore essential that the hazards associated with workers working on roofs are recognised and understood by all relevant stakeholders such as the client or customer and the contractor. *RA should be conducted for work on roofs prior to commencement of work*.

The type of fall hazards depends on several factors, such as:

- roof type or profile;
- roof slope;
- roof height; and
- duration and frequency of work.

Wide-spanning metal roof of industrial building.

Old Industrial building with skylight and asbestos roof sheets.

Pitched corrugated metal sheet roof of residential building.

Glass canopy roof of car porch.

Flat non-fragile roof with low parapet walls.

Pitched tiled roof.

Figure 1: Examples of roof types or profiles in Singapore.

Fall hazards have to be identified at different phases of roof work, including access to the roof, working on roof top, and transfer and placement of work materials to the roof.

2.1.1.1 Access to Roofs

Safe access to the roof must be carefully planned in order to select the most appropriate method and equipment. Potential fall hazards could arise from:

- Gaps between scaffold work and roof edge when crossing over to the roof from the scaffold (should not be more than 300 mm);
- Standing on the top rung of an A-frame ladder to climb onto the roof;
- Lack of secure handholds when transiting from the ladder (A-frame or fixed ladder) onto the roof. This may occur if the ladder does not extend sufficiently from the roof landing (ladder should extend at least 1 m higher);
- Lack of access control to prevent unauthorised access to roof (e.g., permit-to-work [PTW] system);
- Climbing out of a mobile elevating work platform (MEWP) to access the roof is generally not recommended. This should only be considered if all other methods are deemed to be even more hazardous. When exercising this option, continual 100% tie-off to a suitable anchor is needed to ensure the safety of workers. In addition, the following actions should be carried out:
  - The manufacturer of the MEWP should be consulted to establish whether the platform and boom can withstand the forces, moments, and vibration imposed;
  - The manufacturer should be asked if any additional maintenance and inspection is required;
  - If an MEWP is used outside of the manufacturer's intended use, an explicit individual method statement should be written and communicated to all those involved in carrying out work on or near the platform. Special attention should be given to the provision of safeguards to prevent persons and goods

from falling during transfer from platform to building or vice versa, trapping or crushing of person or foot during transfer from platform to building or vice versa (a person or his foot can accidentally slipped into the gap between platform and building), and a failsafe method of immobilising the unit during transference; and

– Having 100% tie-off alone may not be adequate. Further caution as mentioned above should be highlighted when MEWP is used to access the roof. The MEWP can become a dangerous machine that could severely injure or kill a person if it is not properly used for access to roof. If the recommended measures are not adequate or comprehensive, the inadequate measures would do more harm than good.

- Absence of, improper, or inadequate anchorage for use by workers with safety harnesses.

Roof access ladder is not secured to structure at bottom and top rungs.

A secured cat ladder with entry opening barricaded.

Unsafe scaffold used to access roof.

A properly constructed scaffold with hand holds and guardrails for safe access to the roof.

Figure 2: Examples of access to roofs.

2.1.1.2 Working on Roof Tops

There are many potential fall hazards when working on roof tops. These hazards include:

- falling over an unprotected edge on a roof or from part of a roof structure;
- falling through a fragile or unstable roof surface (e.g., fragile skylight);
- falling through openings on roof (e.g., uncompleted area of glass canopy roof); and
- slipping on wet or smooth roof surface especially on pitched roofs.

Working on roof without any edge barricade.

Example of edge protection provided for working on roofs.

Workers painting near open edge of roof without any fall restraint or arresting systems.

Fall restrain systems used to prevent workers from moving close to edge of roof.

Workers on roof without safety harness and anchorage.

Adequate anchorage and safety harnesses are provided for working on roofs.

Fragile roof surface is not identified before work and no safety signage is used to warn workers of hazard.

Fragile roof surfaces are identified and warning signage is provided at designated access point(s) onto roof.

Installation of glass canopy roof without proper access and measures against falling through roof openings.

Installation of glass canopy roof with proper access and work platforms.

Figure 3: Examples of practices for work on roof.

2.1.1.3 Transfer and Placement of Work Materials

Well-planned materials handling and placement have a significant impact on roof work safety as they can:

- Reduce the amount of time spent working on the roof;
- Reduce the amount of travelling around the roof to collect materials;
- Reduce potential of falling over or through the roof caused by handling heavy and unwieldy work materials, for example, large roof sheets or roof trusses; and
- Reduce the possibility of stray work materials falling off the roof and injuring the person below.

When planning to store materials on the roof, the contractor should check and ensure that the existing roof structure can support the bulk weight of the materials. If lifting operations by cranes are required, refer to the *Code of Practice for Lifting Operations* for guidance.

If lifting appliances, such as chain blocks, are used, the lifting appliance should be adequately and securely supported. Such supports should have adequate strength. If the lifting appliance is mounted near the edge of a roof, it is important that suitable guardrails and toe boards are installed to prevent the workers or work materials from falling over.

2.2 Competency and Training

Roof work is a high-risk activity, and it is essential that the contractors chosen to carry out the work are competent to do so.

A contractor should be able to demonstrate:

- Sufficient knowledge of the particular type of roof work, including the relevant fall hazards, they are engaged to carry out and the associated risks;
- Sufficient knowledge and experience on the latest techniques, standards and materials to enable them to carry the work out safely;
- Relevant training (including Work at Heights [WAH] safety) for all the workers or accreditation by a training body; and
- Compliance to relevant legal requirements. They should have obtained any necessary licence, permit, certificate or any other document in order to carry out the work for which the contractor is engaged to do (e.g., registration of workplace).

Implementation of fall control measures relies on the contractor's competence and discipline to ensure that these measures are used consistently and effectively. As such, a trained supervisor should always be at the work site to ensure that the fall control measures are properly set up and are used correctly by the workers.

WSH professionals (e.g., WSH coordinators or WSH officers) may also be engaged to help the contractor during the planning stage and review the method statements to ensure that adequate control measures have been considered.

The Ministry of Manpower (MOM) has approved Accredited Training Providers (ATPs) to conduct the WAH Course for supervisors, assessor and manager. Roofing contractors are strongly encouraged to send their supervisors for this course so that they can be trained to recognise WAH hazards and implement the necessary fall control measures when working on roofs.

A list of ATPs can be found at MOM's website (http://www.mom.gov.sg/workplace-safety-health/applications-registrations).

"Roof work involving asbestos-containing materials (e.g. corrugated asbestos roof sheets, asbestos cemented panels and asbestos ceiling boards) should be carried out only by contractors who are competent in asbestos removal work. A notification of asbestos work must be submitted to MOM under the Factories(Asbestos) Regulations. You may refer to the Guidelines on Removal of Asbestos Materials in Buildings on WSHC's website for more information. (https://www.wshc.sg/wps/portal/AsbestosResources)."

3. Control Measures against Falls

3.1 Hierarchy of Control

The selection of fall control measures and reduction of risks should be accomplished by following the Hierarchy of Control. The approach to the control measures should start from the top of the hierarchy. This means that the contractor should first consider if working on the roof can be avoided ("Elimination") before considering "Substitution" methods and so on. PPE should be the last resort where possible (see Figure 4).

Types of Control Measures	Examples
1. Elimination Total removal of the hazards.	Roof repairs from below on mobile elevated working platforms instead of working on rooftop.
2. Substitution Replacing the hazard by one that presents a lower risk.	Use of scaffolds instead of ladder to access roof.
3. Engineering Control Physical means that limit the hazard.	Barricades for roof edge.
4. Administrative Control Systems of work or work procedures that help to reduce the exposure of workers to the risks of falling.	• Permit to work systems; • Safe work procedures; • Warning signage on fragile roof; or • Toolbox briefing before work.
5. Personal Protective Equipment Equipment or devices used by workers as protection against the hazard.	Safety harness with horizontal lifelines.

Figure 4: Hierarchy of Control.

Fall 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 (SWPs).

Some fall prevention and control measures that can be adopted for roof work are discussed in the following sections. The examples provided are not exhaustive and a combination of these measures may be implemented.

3.2 Safe Access onto Roof

Safe access to any workplace at heights requires careful planning, particularly when work is conducted on the roof. Common means of access onto roofs include:

- scaffolds, including tower scaffolds;
- ladders; and
- roof access in buildings.

This Guide will elaborate on some of these means of access and key points to note to carry work safely.

3.2.1 Use of Scaffolds as Access

Scaffolds are temporary structures that are commonly used as a means of access to workplaces at heights. Tower scaffolds are a particular form of scaffolding that usually consist of fabricated frame units constructed as single-bay towers.

3.2.2 Key Points on Using Scaffolds as Access

- All scaffolds and its components must meet the requirements stipulated in the WSH (Scaffolds) Regulations.
- If a scaffold is 4 m or more in height, it must be erected by an Approved Scaffold Contractor (exclude tower scaffolds).
- A scaffold should be inspected upon completion of its construction, erection or installation, as the case may be; and thereafter every 7 days by a scaffold supervisor prior to use. The scaffold should also be inspected after exposure to weather conditions likely to have affected its strength or stability or to have displaced any part.
- A tower scaffold should only be used on firm ground.
- A tower scaffold equipped with castors (mobile tower scaffold) should be stable in construction and weighed down at the base. Effective locking devices must be attached to the castors in order to hold the scaffold in position (see Figure 5).
- The height of a tower scaffold must not exceed three times its lesser base dimension unless the scaffold is effectively tied to the building or structure. However, even if tied, the tower scaffold shall not exceed eight times the lesser of the base dimensions.

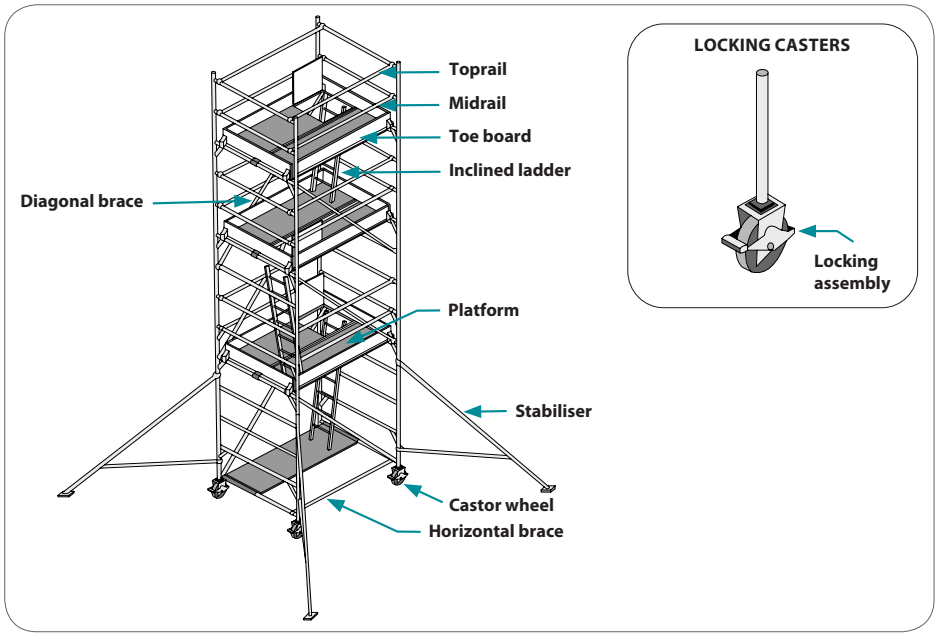

Figure 5: Example of a mobile tower scaffold.

3.2.3 Ladders

Ladders are commonly used as a portable means of temporary access for low roofs. Common types of ladders used include leaning ladders (fireman or cat ladders), A-frame ladders and platform ladders.

As a first step, decide whether a ladder is the most appropriate access equipment compared to the other options. Where a ladder is used as a means of access, adequate handholds should be provided to a height of at least 1 m above the place of landing of the highest rung to be reached by the feet of any person working on ladder.

Ladders leaning against a supporting structure should be set up on a level area on firm footing and the base should be located at a distance approximately a quarter of the vertical height of the ladder from the wall (see Figure 6).

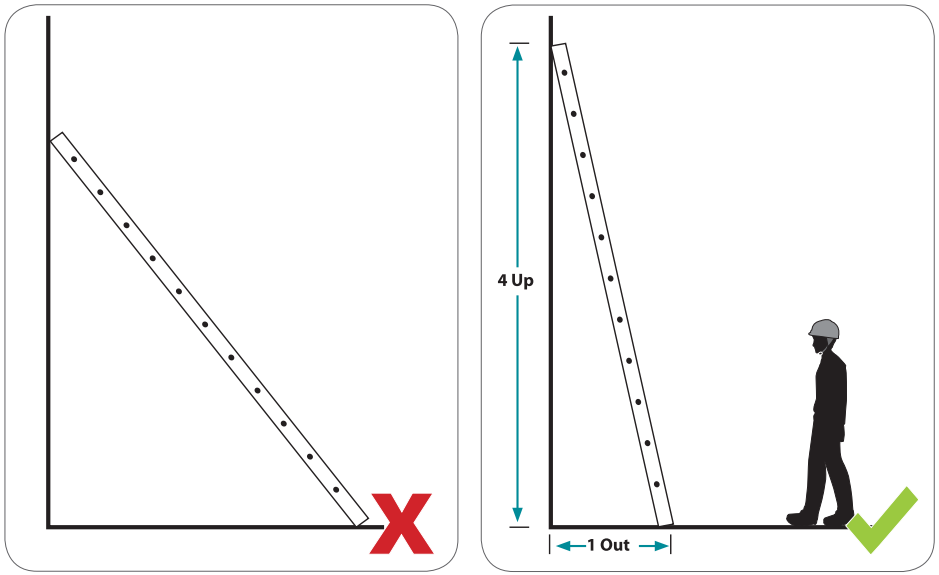

Figure 6: The ratio of the height to the base for a correctly positioned ladder is 4:1

3.2.4 Key Points on Using Ladders as Access

- Before using a ladder, check that it is safe to use. The ladder should:
  - have no visible defects;
  - be clean from oil, grease, wet paint and other slipping hazards; and
  - have been maintained and stored in accordance with the supplier's instructions.
- Ensure that the ladder is firmly secured in place. Do not site the ladder on loose material or slippery surfaces. Ladders should also not be sited in position where user is liable to fall over an open side (e.g., near edge of balcony at second storey to reach terrace roof).
- Persons on ladders should maintain three points of contact at all times, for example, two feet and one hand; or two hands and one foot.
- Do not stand on the top rung of A-frame or step ladders.
- Ensure that the ladder is secured at the top using rope or footed at the bottom before usage. Alternatively, another worker can hold the ladder firmly in place while another is climbing.
- Ladders used to access another level should be tied and extended at least 1 m above the landing point to provide a secure handhold (see Figure 7).

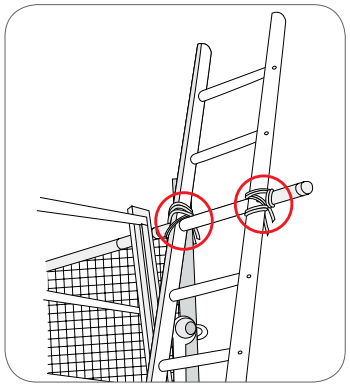

Figure 7: Provision for secured hand-hold landing point.

3.3 Working on Fragile Roof Surfaces

Fragile roof surfaces account for about half of fatal falls from roofs from 2009 to 2011. Falls through fragile roof surfaces are a particular problem in both roof and building maintenance works. Everyone responsible for this type of work, at whatever level, should treat such falls as a priority. This is also important for small, short-term maintenance and cleaning jobs.

In general, fragile roof surfaces refer to parts of the roof which are not designed to bear load and thus are unable to support a person's weight. Persons standing on fragile and brittle roof surfaces, including skylights, are at risk if the roof breaks and gives way under their weight. These roofs typically include those that are constructed from moulded or fabricated materials such as cellulose cement roof sheets, glass, fiberglass, acrylic or other similar synthetic materials.

The following are likely to be fragile:

- roof skylights;
- glass (including wired glass), fiberglass, polycarbonate roof;
- old ceramic roof slates and tiles;
- corrugated asbestos roof sheets;
- asbestos cemented panels or asbestos ceiling boards beneath the roof

Example of skylight on factory roof.

Old corrugated roof sheets.

Glass roof canopy.

Car porch with polycarbonate roofing.

Figure 8: Examples of possible fragile roof surfaces.

3.3.1 Identify Fragile Roof Surfaces

These brittle or fragile areas are to be first identified and the stability of the structure and soundness of the roof are assessed as part of the risk management process before starting roofing work. The contractor should:

- Check details with engineers familiar with relevant building plans related to the roof construction (more applicable for new construction projects);
- Check with clients or occupiers of existing buildings for skylight features on roof,presence of asbestos-containing roofing materials;
- Conduct a visual check without stepping on the roof where possible. If access onto roof is inevitable, provisions for fall protection measures including safety harness with adequate anchorage along route of access should be provided;
- Provide warning signage or clear demarcation around the identified fragile roof surfaces;
- Warning signs are displayed at access points to any work area where fragile material is present and are fixed securely in a position where they will be clearly visible to persons accessing the working area; and
- Implement a buddy system – if a person is required to work on or from a roof that is fragile and can break easily, it is important to ensure that there is another person present at all times when work is being performed on a brittle roof in case of an emergency.

Figure 9: Sticker signage for fragile roof surfaces from WAH kit.

3.3.2 Working on Roofs with Fragile Surfaces

If possible, arrange the work to avoid working on or passing near fragile material. If this is unavoidable, you should identify all fragile materials and put precautions in place to prevent or minimise the effects of a fall. This applies to all operations on the roof, whether construction, maintenance, repair, cleaning or demolition.

The Hierarchy of Control for work on fragile roofs is:

1. Work from underneath the roof using a suitable work platform;
2. If this is not possible, consider using a MEWP that allows people to work from within the MEWP basket without standing on the roof itself;
3. If access onto the fragile roof cannot be avoided, perimeter edge protection should be installed and staging used to spread the load. Unless all the work and access is on staging or platforms that are fitted with guardrails, a harness system should be used or safety nets installed underneath the roof; and
4. When harnesses are used, they need adequate anchorage points. They also rely on discipline, training and supervision to make sure that they are used consistently and correctly.

3.3.2.1 Work Platforms for Roofs

Work on fragile roofs can be carried out from a working platform that is located and constructed to allow work to be performed safely. Work platforms such as crawl boards, roofing brackets and roof ladders can be used to enhance safety for work on fragile or brittle roofs.

Key points to note:

- Work platforms for use on roofs should be of safe design, sound material, good construction and adequate strength.
- Crawl boards shall extend from the ridge pole to the eaves when used in connection with roof construction, repair or maintenance.
- Every crawl board shall be secured to the roof by ridge hooks or equally effective means.
- A firmly fastened lifeline of adequate strength shall be strung beside each crawl board throughout its length.
- Roofing brackets should be constructed to fit the pitch of the roof and when in use shall provide a level working platform.
- Roofing brackets shall be secured in place by nailing pointed metal projections attached to the underside of the bracket and securely driven into the roof or by a secure rope passed over the ridge pole and tied.

3.3.3 Openings on Roofs

Opening on roofs can also lead to fatal falls. Sometimes the openings are created in the course of work on roofs (e.g., removal of a roof sheet for replacement). Here a cover including any rigid object may be used to overlay openings in roofs, other fragile walking and working surfaces. The covers must be able to support at least twice the maximum anticipated load of workers, equipment and materials. Covers should have full-edge bearing on all four sides. The constructor has to ensure that covers are secure and colour-coded or marked with the word "HOLE" or "COVER".

Work on canopy roofs is one such example where openings are created in the course of the roof work. Contractors performing canopy roof work should:

- Work from bottom of the roof where possible.
- Provide safe and proper means of access and egress for all personnel
- All personnel tasked to access or work on roofs are trained to work safely at heights.
- Install temporary edge protection where possible
- Provide sufficient and secured anchorage for the use of a full-body harness or a restrain belt.
- Stop work should there be inclement weather.

3.4 Measures against Falling off Edge of Roof

When working on roofs, it is essential to protect workers from falling from the edge of the roof. "Edge protection" is the term commonly used to describe measures that can be used to prevent workers falling from the roof edge.

There are a number of popular systems to do so:

- full scaffold;
- guardrail; and
- proprietary guardrail systems.

The most appropriate system will depend on factors such as:

- type of work;
- type of roof;
- roof slope; and
- size and weight of materials being used.

When the design of the roof does not provide permanent and effective edge protection, such as solid parapet wall, temporary edge protection such as guardrails will be required. Guardrails erected should fulfill the following:

- They should be well-constructed, be made of sound material with adequate strength to withstand the impact during the course of work at the worksite;
- They should be placed and secured on the inside of the roof edge so as to prevent accidental displacement;
- They should be placed so as to prevent the fall of any person; and
- The uppermost guardrail shall be at least 1 m above the work platform or workplace for which the guardrail is provided. The vertical distance between any two adjacent guardrails; and between any work platform or workplace and the guardrail immediately above it, shall not exceed 600 mm.

Figure 10: Examples of ineffective barricades.

When roofs are steep and/or materials are large or heavy, the risk is greater hence a full scaffold may be the most appropriate. Other possible edge protection for roofs include proprietary guardrail products available in the market.

Scaffolds offering roof edge fall protection.

Guardrails erected at edge of flat roof.

Guardrails erected on roof surface.

Example of proprietary guardrail products.

Figure 11: Examples of edge protection for roofs.

3.5 Other Measures – Safety Nets

In addition to perimeter guardrails, travel restraint system or individual fall arrest system, safety nets can be effectively deployed to reduce the distance of potential falls and to minimise their effects. Safety nets will not prevent a worker from falling but it reduces the severity in the event of a fall. Thus it contributes to reducing the risk associated with a task. They allow a broad range of activity to continue with minimum restriction.

A good safety net system should have high energy absorption, and offer a "soft landing" that minimises injury. They should always be fitted as close as possible to the underside of the working platform to minimise the distance and consequences of a fall.

For more details on safety nets, refer to *Singapore Standards SS 292 : 1984 Safety nets for construction sites.*

Safety nets can be used effectively:

- To minimise injury due to falls from leading edges, through liner panels or through temporarily fixed materials in newly-build roofing;
- To guard roof lights and fragile roof materials during cleaning, maintenance and replacing of the roof; and
- To minimise injury from falls during roof truss erection, for example, when fitting diagonal bracing (see Figure 12).

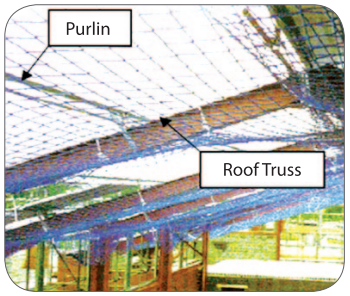

Figure 12: Safety nets in use for roof works.

(Photo courtesy of Advisory Committee of Roof Work-Guidance Note on Safe Working on Fragile Roof)

4. Administrative Controls

Administrative controls are systems of work or work procedures that help to reduce the exposure of workers to the risks of falling. However, the effectiveness of such controls depends heavily on the manner of implementation on-site over time. Administrative controls may also be used to support or used in conjunction with other control measures that are put in place. The two key administrative controls include PTW and SWPs.

4.1 Permit-to-Work System

Under the WSH(Work at Heights) Regulations 2013, the Permit-to-Work(PTW) system is required to be implemented for any work in a workplace where a person could fall a distance of more than 3 metres. A PTW system is a formal written system used to control certain types of work that are potentially hazardous such as working at heights. It works by assigning different roles to key levels of site personnel to ensure that all safety conditions and adequate control measures are fulfilled before allowing work to commence. Table 1 illustrates the PTW process in the context of a construction worksite.

Stage of PTW	Roles in PTW	Duties in PTW
Application of Permit	**Applicant** Supervisor	• Apply for permission to commence work via PTW form; • Implement all stated control measures and conditions; • Inform workers of work hazards; and • Submit application for PTW to Assessor.
Evaluation of Permit	**Assessor/ Checker** Safety Assessor	• Assess and verify that all reasonable and practicable measures are taken as stated in PTW; • Inspect the site with the supervisor of the person who is to carry out the work where the high-risk construction work is to be carried out (including its surroundings); and • Submit for approval when Assessor/ Checker is satisfied that all necessary measures are in place according to PTW .

Stage of PTW	Roles in PTW	Duties in PTW
Issue of Permit	**Approver** Authorised Manager	Approve and issue PTW when the following are satisfied: • Verify that there has been a proper evaluation of the risks and hazards; • Ensure that no incompatible work will be carried out at the same time in the same vicinity as the high-risk construction work; • All reasonably practicable measures will or have been taken for high-risk construction work; and • All persons who are to carry out the high-risk construction work are informed of the hazards associated with it.

Table 1: Overview of PTW system with reference from Part III of WSH (Construction) Regulations

Some points for effective implementation of PTW system include:

- The PTW should be specific in the locations and duration of work required;
- The permit can be used for multiple work areas only if it has been assessed that the work areas share similar fall from height hazards, and that the control measures taken are applicable and effective in all the work areas covered by the permit;
- The permit can be used for extended duration only if it has been assessed to be deemed necessary, and that the control measures taken are effective throughout the entire duration of the permit. The maximum duration of such permit is seven days; a daily review is required for such permits;
- A copy of the approved PTW should be prominently displayed at the work site;
- The PTW approved is only valid for the period stated, and if the work for which the PTW is issued is not completed within the validity period, a fresh application has to be made; and
- No PTW should be applied in advance before the actual preparations of the workplace and the stated controlled measures are implemented.

Details on PTW system, including a sample PTW template can be found in the Code of Practice for Working Safely at Heights.

4.2 Safe Work Procedures

SWPs are the most common form of administrative controls in workplaces. It is a set of systematic instructions on how work can be carried out safely. Using information obtained from RA, a set of SWPs should be developed for various roof work activities.

A SWP generally provides instructions on how roof work activities are to be performed, persons involved in these jobs, the safety precautions to be taken and the training and/or certification necessary to carry out these jobs competently. The SWP must be communicated to everyone involved in the roof work so that each person is aware of his roles and responsibilities. The SWP must also be communicated to those who will be affected by the job.

A comprehensive SWP for work on roofs should include:

- Identification and signage for fragile roof surfaces;
- Designated means of safe access to roof;
- Ensuring that warning signs are displayed on existing roofs, particularly at roof access points;
- Edge protection and other fall prevention such as working platforms;
- Implementation of fall protection systems such as use of safety harness and adequate anchorage at areas of access required on roof;
- Proper planning for placement of materials on roof where applicable. For example, by arranging for the right materials to be lifted to the right place at the right time, it will reduce the need for workers to move about the roof;
- Refer to method statement or step-by-step process of carrying out work safely;
- Distinct roles of workers in work process, if any;
- Type of equipment required in work process and pre-operations checks;
- Type of PPE provided and its proper usage;
- Communications to workers (e.g., on work hazards and PPE usage);
- Supervision; and
- Emergency response procedures to rescue an arrested fall (refer to Section on "Rescue of Workers Who are Using Individual Fall Arrest Systems" in the *Code of Practice for Working Safely at Height*).

Note: Roof works must not be carried out under adverse weather conditions. This includes immediately after a rain because the surface of the roof will be slippery. There is also the risk of being struck by lightning.

5. Personal Protective Equipment

PPE are equipment or devices worn or used by workers to protect themselves against or minimise the harm due to the workplace hazard.

They should be used only as a last resort, after all other control measures have been considered, or only for a short period during maintenance or repair, or only as an additional protective measure.

The effectiveness of PPE as a control measure is dependent on the correct equipment being chosen, fitted and worn properly at all times when required by users.

Before selecting the most appropriate PPE, the worker should take into consideration:

- the type of hazard;
- areas of the body that require protection;
- the degree of protection required;
- ease of use, comfort and convenience;
- reliability; and
- ease of maintenance.

The two most common types of PPE used in roof work are travel restraint and fall arrest systems.

5.1 Travel Restraint System

A travel restraint system is a system that allows a worker to carry out their job but prevents them from reaching any position from which they could fall (see Figure 13). Where practicable a travel restraint system should be used in preference to fall arrest. A travel restraint system:

- Consists of a safety harness or belt, attached to one or more lanyards, each of which is attached to a static line or anchorage point; and
- Is designed to restrict the travelling range of a person wearing the safety harness or belt so that the person cannot get into a position where the person could fall off an edge of a surface or through a surface.

A travel restraint anchorage should be capable of withstanding a static load of 4.5kN or two times the foreseeable force and should conform to *Singapore Standard SS 541 – Specification for restraint belts*.

A roof anchor may be used as a travel restraint on steel sheeting or tiled roofs during construction of the roof. It is lightweight, portable and can be installed and removed with minimal time and effort. Travel restraint systems can be used in conjunction with other fall protection methods such as guardrails.

The travel restraint system should prevent a person falling from the edge of a roof. A travel restraint system is not designed to stop or sustain falls.

Before a travel restraint system can be used, the following conditions should be complied:

- The system should *not* be used on fragile roofs; and
- Persons setting up and/or using the system should be able to demonstrate that they have a clear and thorough understanding of the system and how the work area can be accessed without the possibility of a fall occurring.

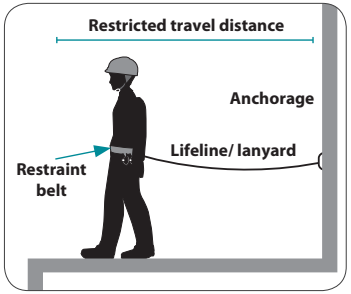

Figure 13: Overview of travel restrain system

Travel restraint systems are generally only suitable for work such as:

- roof inspection (not on fragile roofs);
- installation and removal of perimeter guardrail systems;
- minor repair work, including replacement of some isolated parts of the roof;
- painting and cleaning;
- installation of skylights and ventilation fixtures;
- pointing up tiles or fitting ridge capping metal roofs; and
- installation and removal of television aerials and other similar communication equipment.

Where access to the corner of the roof is required, workers should be attached to two or more sets of ropes and anchorages to prevent a fall from either edge of the roof. While accessing the anchorage points, the users should be restrained so that a fall cannot occur.

5.2 Individual Fall Arrest System

Individual fall arrest systems are intended to safely stop a worker from falling an uncontrolled distance and to reduce the impact of the fall. They are an assembly of interconnected components typically consisting of a full body harness system connected to an anchorage point or anchorage system either directly or by means of a lanyard (see Figure 14). They can be used where workers are required to carry out their work near an unprotected edge.

For more details on the components of an individual fall arrest system, refer to the *Code of Practice for Working Safely at Height*.

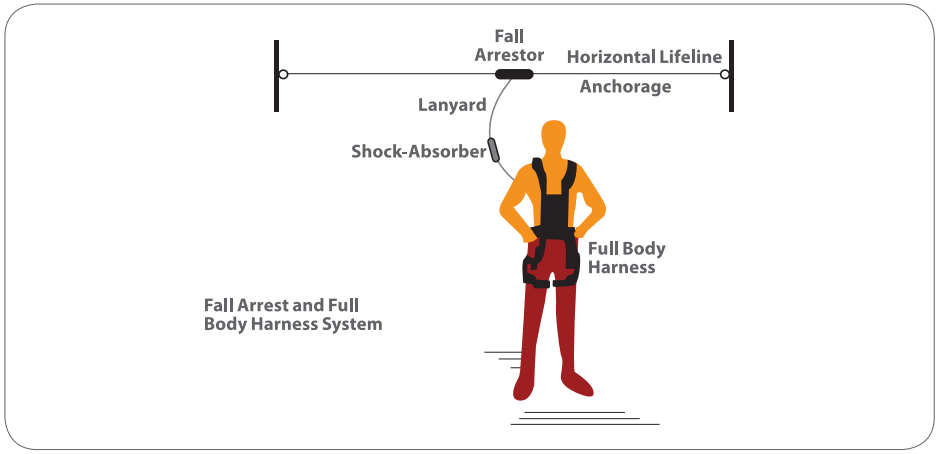

Figure 14: Overview of a fall arrest system.

For a fall-arrest system to function correctly, there must be adequate fall clearance beneath the work area.

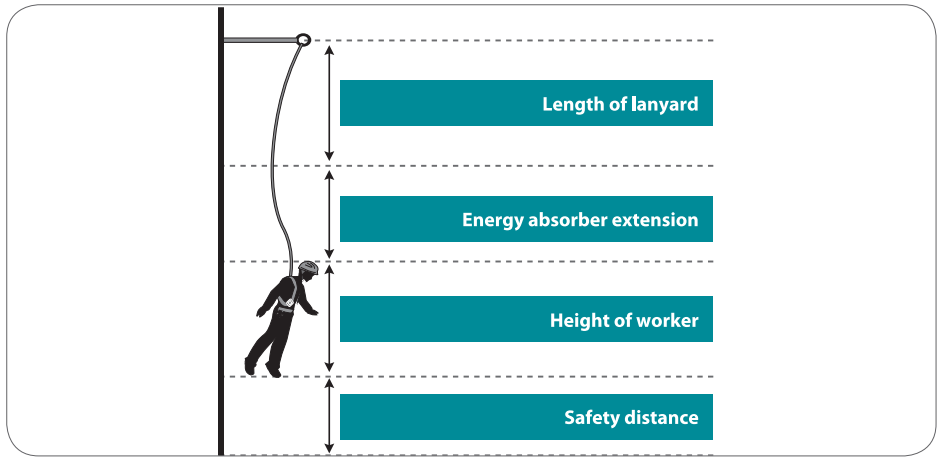

Figure 15: A graphical representation of the formula for calculating clearance height.

For a person falling from heights, the combined length of the lanyard, sag in life line and the shock absorber fully extended may be more than 5 m in total. These 5 m might be more than the actual height of the fall (see Figure 15). Therefore, when working in areas where falls over short distances are possible, a short lanyard or retractable fall arrest block should be considered.

For a harness, lanyard with energy absorber assembly:
Clearance Height = Length of Lanyard + Length of Energy Absorber Extension + Height of Worker +Safety Distance (usually taken as 3 ft /1 m)

For a Self Retracting Lifeline (SRL)/ Retractable Fall Arresters:
Clearance Height = Deceleration Distance + Height of Worker + Safety Distance (Usually taken as 3 ft/1 m)

100 Percent Tie-off

A safety harness is able to provide protection from falls only if the harness is always attached to a lanyard that is anchored or if the "100 percent tie-off" is achieved. The term "100 percent tie-off" means that anchorage is maintained at all times. This is done to allow for fall protection even when transferring between two separate anchorage points.

A "100 percent tie-off " will require twin-tailed lanyards that allow users to remain anchored to one point of anchorage with one lanyard, while transferring to another point of anchorage with the second one.

Avoid swing falls

There are some hazards when using the individual fall arrest systems. One such hazard is "swing back" and "swing down". It is caused by the pendulum effect of a person falling off the edge (see Figure 16).

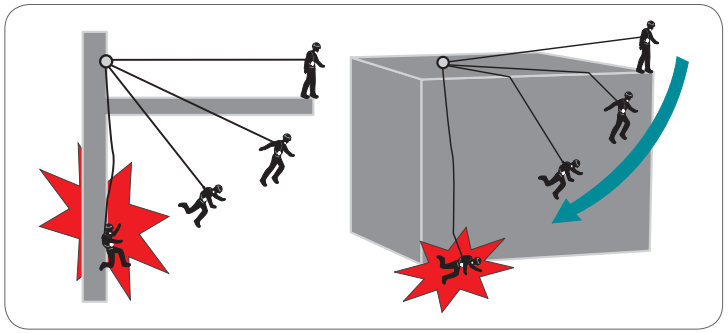

Figure 16: Illustrated examples of a swing fall.

5.3 Anchorage

Anchorage is the complete set of fittings, already installed to a structure, to which a safety lanyard may be attached. These are also often known as anchor points (see Figure 17).

Anchorage used for attachment of individual fall arrest equipment must be in general capable of supporting the forces generated by a fallen worker (about 22.2kN per person attached) or must be designed and used:

- as part of a complete personal fall arrest system which maintains a safety factor of at least two; and
- under the supervision of a qualified person.

Employer should refer to the manufacturer's instructions or the recommendations of a competent person for proper installation

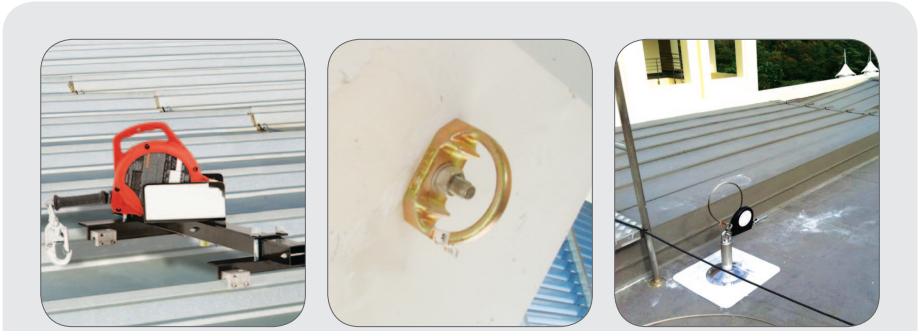

Figure 17: Some examples of anchorages.

5.4 Lifelines

In cases where direct attachment to anchorages is not possible, life lines provide the interface between a user's fall arrest harness and the anchorage. Refer to Annex 2 for more details on lifelines.

Lifelines are typically flexible cables or ropes that connect to a body harness, lanyard, or deceleration device and at least one anchor, and they include:

- Vertical lifeline: A flexible line connected to an anchorage at one end and hung vertically.
- Horizontal lifeline: Where both ends are connected to anchorages and stretched horizontally.
- Self-retracting lifeline or SRL: Consists of a drum-wound line that unwinds and retracts from the drum as a worker moves. If the worker falls, the drum automatically locks and halts movement of the lifeline. The self-retracting lifeline can be both a vertical lifeline and a deceleration device depending on product design.

Example of horizontal lifelines on roof.

Example of a self-restraint lifeline.

Figure 18: Examples of lifelines.

3.3.3 Engaging Specialist Professionals

For access on roofs when conventional fall prevention measures may be difficult, WAH specialists such as qualified rope access technicians may be engaged to set up lifelines for the rest of the workers or conduct an initial survey on fragility of roof surfaces before commencement of work.

When roof works is carried out on buildings suspected to contain asbestos (e.g., dismantle asbestos roof sheets), asbestos specialist contractors may be engaged to manage these additional risks to workers' health at work. You may refer to WSH Council's Guidelines on *Management of Asbestos* (www.wshc.sg).

Useful References

- Code of Practice for Working Safely at Height
- Guideline to Risk Management (www.wshc.sg)
- HSE's 'Health and Safety in Roof Work' (HSG33-available for download at www.hse.gov.uk)
- HSE's 'Minor Roof Maintenance Work: Protecting against Falls' (Info sheet 5-available for download at www.hse.gov.uk)
- Singapore Standard CP 14 : 1996 – Code of Practice for Scaffolds
- Singapore Standard CP 79 : 1999 – Code of Practice for Safety Management System for Construction Worksites
- Singapore Standard SS 292: 1984 – Specification for Safety Nets for Construction Sites
- Singapore Standard SS 311: 2005 – Specification for Steel Tubes and Fittings Used in Tubular Scaffolding
- Singapore Standard SS 528 : Part 1 : 2006 – Specification for Personal Fall Arrest Systems – Part 1 : Full-body Harnesses
- Singapore Standard SS 528 : Part 2 : 2006 – Specification for Personal Fall Arrest Systems – Part 2 : Lanyards and Energy Absorbers
- Singapore Standard SS 528 : Part 3 : 2006 – Specification for Personal Fall Arrest Systems – Part 3 : Self–retracting Lifelines
- Singapore Standard SS 528 : Part 4 : 2006 – Specification for Personal Fall Arrest Systems – Part 4 : Vertical Rails and Vertical Lifelines Incorporating a Sliding-type Fall Arrester
- Singapore Standard SS 528 : Part 5 : 2006 – Specification for Personal Fall Arrest Systems – Part 5 : Connectors with Self-closing and Self-locking Gates
- Singapore Standard SS 528 : Part 6 : 2006 – Specification for Personal Fall Arrest Systems– Part 6 : System Performance Tests
- Singapore Standard SS 570 : 2011 – Specification for Personal protective equipment for protection against falls from a height – Single point anchor devices and flexible horizontal lifeline systems
- Suspension Trauma, its Effects, Prevention and Treatment Methods (www.suspensiontrauma.info)
- Advisory Committee for Roofwork Safety (ACR), UK website (http://www.roofworkadvice.info/html/publications.html)
- Technical Advisory for Work at Height (www.wshc.sg)
- Workplace Safety and Health Act 2006
- Workplace Safety and Health (Construction) Regulations 2007
- Workplace Safety and Health (General Provisions) Regulations
- Workplace Safety and Health (Risk Management) Regulations
- Workplace Safety and Health (Scaffolds) Regulations 2004
- Guidelines on Removal of Asbestos Materials in Buildings(www.wshc.sg)
- Workplace Safety and Health (Asbestos) Regulations
- Workplace Safety and Health (Work at Heights) Regulations 2013
- WSH Guidelines – Personal Protective Equipment for Work At Heights,
- WSH Guidelines – Anchorage, Lifelines & Temporary Edge Protection Systems

Annex 1: Work at Heights Checklist for Work on Roofs

This checklist serves to highlight key considerations during roof works to help contractors better implement control measures to manage fall hazards in their workplaces. The checklist is by no means exhaustive and is not a replacement for proper planning including the fall prevention plan and RA.

Stage of Work	Key Considerations

Pre-work Planning and Preparation	• Consider if working on roof can be avoided (e.g., from below on mobile elevated working platforms [MEWP]).
	• The Fall Prevention Plan (FPP) for work on roofs, should include :
	  • Hazard identification and Risk Assessment (RA) - identify fragile or asbestos roof surfaces if any;
	  • Method statement or process to carry out work;
	  • Administrative controls including permit-to-work (PTW) and safe work procedure (SWP); and
	  • Brief workers on hazards of work and fragile roof locations (where applicable) and control measures.
	• Identify other workplace hazards such as from asbestos roof materials (for old buildings built before 1989)

Accessing the Roof	• Establish appropriate designated means of safe access. • If access equipment such as MEWP is used; conduct pre-operations check and ensure statutory examination are complied. • If scaffolds are used as access; ensure compliance to Workplace Safety and Health (Scaffolds) Regulations. • Install warning signage for fragile roof and prevent unauthorised access.
Transfer and Placement of Work Materials	• Ensure that location on roof can take the load of materials to be transferred. • Ensure that proper placement for transferred materials (e.g., racks for glass sheet canopy) to prevent toppling or falling off the roof. • If lifting operations by cranes are required, ensure a Lifting Plan is presented according to *Code of Practice for Safe Lifting Operations.* • If lifting appliance (e.g., chain block) is mounted near edge of roof, ensure that suitable guardrails and toe boards are installed.
Working on Roofs	• Establish designated safe route of access on roof to minimise unnecessary movement across the roof. • Provide anchorage for use for individual fall protection equipment to ensure 100% tie-off. • Demarcation or barricades around fragile roof surfaces where applicable. • Provide crawl boards or roof brackets where applicable. • Provide barricades for edge protection where applicable.

Annex 2: Information on Lifelines

Introduction

In cases where direct attachment to anchorages is not possible, lifelines provide the interface between a user's fall arrest harness and the anchorage.

A lifeline typically consists of a flexible line connected to an anchorage at one end and hung vertically (vertical lifeline [VLL]) or where both ends are connected to anchorages and stretched horizontally (horizontal lifeline [HLL]). There also exists a third type, the self-retracting lifeline, which is secured above the attached user. The tensioned lifeline extracts and retracts automatically in response to movements of the worker attached to it. In the event of a fall, the sudden movement experienced engages a braking system similar to those used in car seat belts and halts movement of the lifeline.

General Information on Lifelines

Lifelines are typically made of synthetic fibre ropes, webbing material or wire ropes, with the ends suitably terminated. It must be noted that the requirements below are the minimum and are meant to address general cases, certain specific cases will necessitate higher requirements, this is especially so for HLL systems.

Wire fibre is much more resistant to ultra-violet (UV) light and environmental exposure than artificial fibres used to construct fibre ropes, therefore, lifelines made from wire fibre are more suitable for lifelines intended for outdoor long-term or permanent use.

Where lifelines are used, supervision must be provided. Equipment and plans for emergency rescue should also be made available.

Switching lifelines

Where it is necessary for a user to switch between lifelines, the second lanyard must be connected to the next lifeline before the connection to the previous lifeline is disengaged. This is commonly known as 100-percent tie off.

Storage

When not in use, lifelines should be stored separate from possible hazards, such as sharp objects, heat, sunlight, chemicals or flammable substances. Exposure to such hazards may result in the lifeline being degraded without being noticed.

Selection of lifelines

Consideration should be put into the following factors when deciding on the type and positioning of lifelines. Below are four factors that have been identified that affect the compatibility of types of lifelines. By no means should consideration be limited to these four factors, other factors should be included for consideration, depending on the situation or conditions of the site.

Ease of Use

The type of work to be carried out may affect the suitability of the type of system, where possible, the least cumbersome one should be chosen. If the system hinders the user from carrying out the work too greatly, the users may end up choosing to disengage themselves from the lifeline and carry out the work unprotected.

Length of Service

The system should match the expected term of use, using a fibre-rope lifeline for long-term or permanently, may put users at risk. Due to long-term environmental exposure, the lifeline may become weakened and be unable to withstand the forces generated during a fall.

Conditions

The type of lifeline used should be suitable for use under severe conditions, if exposure to substances such as corrosive agents, high temperatures or harsh weather is expected.

Protection of Lifelines

Adequate protection should be provided to the lifeline especially if it is at risk of being damaged by abrasion, hot works or where it may be accidentally cut. Below are a few conditions that can weaken or damage the lifeline, compromising the degree of protection that is afforded by the lifeline.

Ultraviolet light: Prolonged exposure to sunlight will weaken synthetic fibre rope lifelines. Lifelines made from ultraviolet-resistant materials should be used in such cases.

Temperature: Extreme heat (such as from machinery) can weaken lifelines; extreme cold can cause lifelines to become brittle. Under such conditions, lifelines used should be made of materials capable to withstanding extreme temperatures.

Physical damage: Contact with sharp objects, rough surfaces will damage the lifeline directly. Protection of lifelines at contact points can be done using padding material such as rubber mats mounted onto the surface or through the use of specialised rope protectors.

Sparks or flame: Extreme heat sources, such as those generated during hot works, can melt or burn lifelines. Where possible, lifelines should be kept away from or at least guarded from exposure from sparks or flames; if guarding is not possible, they should be constructed from flame-resistant materials.

Chemicals: Exposure to chemicals can cause lifelines to be either chemically burnt or degraded. Where chemicals are used, measures should be taken to prevent contact with lifelines; if contact cannot be avoided, the lifeline should be constructed from chemically resistant or inert materials.

Marking or dying: Only dyes approved by the manufacturer can be used to mark lifelines, as most conventional dyes contain acids which can result in the weakening of the lifeline.

Adequate coverage

It is important to provide sufficient coverage for users performing work while anchored to the lifeline. Inadequate coverage may result either in users disengaging themselves from the lifeline or "swing back" collisions, in the event of a fall.

Other factors should be included, such as the situation on the site and the nature of the work to be carried out.

Types of Lifelines

There exist many types of lifelines, in this Annex, information on the three basic types have been included. There also exist devices like sliding rails and rigid-type horizontal fall arrest systems, due to the complexity and variation that exists in different models from different manufacturers, information on such devices have not been included here.

Vertical Lifelines

A VLL is constructed when a lifeline is secured on one end to an anchorage, with the other end is left to hang vertically. Users are then connected to the line using a personal fall arrest system that moves with the user vertically up and down the lifeline. Under normal circumstances, each VLL is to be used by one user only.

The lifeline should be free of knots and splices, as they will weaken the lifeline; the exception is where knots are used to secure the lifeline to an anchorage, this should only be done by competent persons, who are trained and experienced in the use of knots for such purposes. The end of the lifeline that is to be used for connection to the user's harness must be terminated with a swivel connector. Lifeline terminations must not be formed by tying knots in the lifeline.

Additionally, the lifeline used must be long enough to reach either the ground or a secure location so that the user may safely exit should the need arise.

Self-Retracting Lifelines

A self-retracting lifeline involves the use of a spring-loaded reel to reel in any excess length of lifeline, ensuring a shortest possible length of lifeline between the user and the reel. In the event of a fall, the lifeline is rapidly pulled out on the reel a braking mechanism is engaged to halt the fall of the user.

Self-retracting lifelines are usually designed to be anchored above the user and should be used as such, unless otherwise stated by the manufacturer.

It is often easy to misuse the self-retracting lifeline system, causing them to fail to provide the intended protection from falls. Thus, it is important to follow the instructions of the manufacturer when using such systems. Below is a list of situations where the degree of safety of the self-retracting lifeline can be compromised. As such, the following practices *must not* be allowed:

- Use in the horizontal plane; unless the manufacturer had done testing in this direction, and has specifically permitted such usage.
- Usage/ attachment on a HLL, unless the manufacturer had done testing in such a situation and has specifically permitted such usage.
- Usage in cases where the lifeline has to pass or trail over sharp edges such as a roof's edge. The line may be weakened due to abrasion, this effect will be compounded by the movements of the lifeline due to the movements of the user.
- Attaching a lanyard between the lifeline and the harness may increase the fall distance and should be avoided.
- Attempting to extend the lifeline beyond its normal working length, the linkages may not be of sufficient strength to withstand the forces generated during a fall.
- Tampering, modifying the device or joining more than one device together. The device may no longer function as intended.
- Attachment of more than one user to each device, overloading may occur; self-retracting lifelines are meant for usage by only one user.
- Re-using a device that had previously arrested a fall. Such devices will usually have indicators that will show if it had arrested a fall previously, although some may not. Such devices should be withdrawn from usage. The manufacturer's manual should contain information on how to perform such checks.
- Allow rapid-retraction of the lifeline, this may result in a higher chance of jamming or failure due to the rapid spooling of the lifeline.

Horizontal Lifelines

A HLL basically consists of a lifeline rigged horizontally, with each end secured to an anchorage. Users are then connected to the line using a personal fall arrest system that moves with the user between the two anchorage points.

This type of lifeline is the most complicated to design. Due to the unavoidable deflection that will occur if a user falls while being anchored to it, standard guidelines for anchorages and lifelines may become insufficient due to the horizontal deflection. Therefore, HLLs must be designed, installed, and used under the direction of a competent person who is capable of determining load requirements, fall arrest requirements, and has been trained in identifying hazardous conditions relating to fall arrest systems.

It is vital to be aware of and keep within the design specifications of the HLL. The maximum number of persons attached to the lifeline specified must never be exceeded. The deflection of the HHL due to a person's fall is important for calculating the fall clearance distance.
The height of a HLL should be higher than the waist level, as a lifeline system is generally intended for fall arrest, not for travel restraint.

Refer to *Singapore Standard SS 570 : 2011 – Specification for Personal protective equipment for protection against falls from a height – Single point anchor devices and flexible horizontal lifeline systems*, for further guidance.

Inspection of Lifelines

Lifelines must be visually checked for damage, if the lifelines are left at the site of usage, they must be inspected on a daily basis or before each time they are used.

If any of the following are found, the lifeline is unsafe and must be withdrawn from usage.

- tears or cuts (broken or loose strands);
- glazing of surface (heat damage);
- varied strand size or shape;
- decreased elasticity (stiffness) or presence of lumps;
- discolouration;
- lack of proper termination;
- unclear/ missing identification or inspection labels; or
- connecting hardware is damaged or in poor condition (e.g., unable to lock).

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