



SANFORD UNDERGROUND RESEARCH FACILITY

SOUTH DAKOTA SCIENCE AND TECHNOLOGY AUTHORITY

Fall Protection and Prevention Standard

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Revision History

Rev	Date	Section	Paragraph	Summary of Change	Authorized by
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1.0 Purpose

It is the purpose of the Sanford Underground Research Facility (SURF) that all risk associated with fall hazards shall be managed to prevent harm to personnel. This standard documents processes, systems, and tools to mitigate risk associated with fall hazards.

SDSTA complies with the following to fulfill this standard:

- 29 CFR 1910, Subpart D (Walking-Working Surfaces)
- 29 CFR 1910, Subpart F (Powered Platforms, Manlifts, and Vehicle-Mounted Work Platforms)
- 29 CFR 1910, Subpart I (Personal Protective Equipment)
- 29 CFR 1926, Subpart M (Fall Protection)
- 29 CFR 1926, Subpart L (Scaffolds)
- 29 CFR 1926, Subpart X (Stairways and Ladders)

2.0 Scope

This standard applies to all South Dakota Science and Technology Authority (SDSTA) personnel, users and contractors/subcontractors. This standard applies to all SDSTA activities at SURF that expose personnel to falls.

3.0 Definitions

Aerial Lift – Any mechanized device, telescoping or articulating, that can move vertically and horizontally to position personnel. For fall protection purposes at SURF, JLG® and LiftPod™, etc. are considered aerial lifts (See Figure 1).



Figure 1: JLG Aerial Lift™

Anchorage – Also known as an anchor or anchor point. A secure point of attachment solely dedicated for the use of lifelines, lanyards or deceleration devices able to withstand 5,000 pounds of dead weight per person (fall arrest) and 3,000 pounds per person (fall restraint).

Attending Person(s) – A person or persons in the immediate area (within visual or audible range) who can act to rescue or summon help to aid in a rescue of a suspended person in the event of a fall from height.

Body Harness – Personal fall protection device shall be secured about the worker in a manner that will distribute the fall arrest forces over at least the thighs, pelvis, waist, chest and shoulders with means for attaching it to other components of a personal fall protection system.

*Note: reference manufacture user instructions for medical concerns/conditions.

Competent Person – A person who is capable of identifying existing and predictable hazards in any personal fall protection systems or any component of it, as well as in their application and uses with related equipment and who has authorization to take prompt, corrective action to eliminate identified hazards.

Cover – A barrier used to cover a floor opening and is capable of supporting, without failure, at least twice the weight of personnel, equipment and materials that may be imposed on it.

Deceleration Device – Any mechanism that serves to dissipate energy during a fall from height.

Deceleration Distance – The additional vertical distance a falling worker travels, excluding lifeline elongation and free fall distance, before stopping, from the point at which the deceleration device begins to operate. It is measured as the distance between the location of a worker's body harness attachment point at the moment of activation (at the onset of fall arrest forces) of the deceleration device during a fall from height, and the location of that attachment point after the worker comes to a full stop.

Exposed Opening – An opening through which a person may be exposed to fall from height risk that is at least 30 inches high and at least 18 inches wide, through which an employee can fall to a lower level.

- An unprotected edge along the periphery of a walking/working surface such as an edge of a flat roof (except at entrances to points of access, e.g. stairway entries).
- Hole means a gap or void 2 inches or more in its least dimension, in a floor, roof, or other walking/working surface.

Fall – Loss of bodily stability resulting in physical impact.

Fall from Height – An uncontrolled rapid descent from a walking/working surface to a lower elevation greater than four feet.

Fall Prevention – A means to prevent workers from falling onto, through or from a walking/working surface.

Fall Protection – A system of criteria, procedures and equipment to protect persons from injuries due to a fall from height that consists of either fall prevention and/or personal fall arrest.

Fall Rescue Device – Equipment specifically designed for providing rescue to suspended personnel who have sustained a fall.

Fall Rescue Plan – A predetermined plan required whenever the free-fall distance could result in the worker left in a suspended position.

Fall Restraint – A fall protection system that prevents the user from reaching an exposed opening where the user can fall from height. The system is composed of a body harness, along with an anchorage, connectors and other necessary equipment.

Free Fall Distance – The vertical displacement of the fall arrest attachment on the worker's body harness between onset of the fall and just before the system begins to apply force to arrest the fall. This distance excludes deceleration distance and lifeline/lanyard elongation but includes any deceleration device slide distance or self-retracting lifeline/lanyard extension before they operate and fall arrest forces occur.

Guardrail System – A barrier capable of withstanding, without failure, a force of at least 200 pounds applied in a downward or outward direction within two inches of the top edge, at any point along the top rail.

Hazard – Condition, event or circumstance that could lead to, or contribute to, an unplanned or undesirable event. A hazard is the potential for harm. In practical terms, a hazard often is associated with a condition or activity that, if left uncontrolled, can adversely affect personnel, equipment or the environment.

Lanyard – A flexible line of rope, wire rope or strap which generally has a connector at each end for connecting the body harness to a deceleration device, lifeline or anchorage. There are two types of lanyards:

- **Fall factor 1** - A type of fall protection equipment designed to limit the free fall distance to no more than 6 feet. It is used when the anchorage point is positioned above the user's harness attachment point. The primary purpose of an FF1 lanyard is to reduce the force exerted on the worker's body during a fall by minimizing the fall distance and ensuring that the maximum arresting force does not exceed approximately 900 pounds.
- **Fall factor 2** - A type of fall protection equipment designed to allow a free fall distance of up to 12 feet. It is intended for use when the anchorage point is at or below the user's harness attachment point, which can result in a longer free fall. An FF2 lanyard is built to handle higher arrest forces, typically up to around 1,800 pounds, due to the increased fall distance.

Lifeline – A component consisting of a flexible line for connection to an anchorage at one end to hang vertically or for connection to anchorages at both ends to stretch horizontally and which serves as a means for connecting other components of a personal fall arrest system to the anchorage.

Personal Fall Arrest System – A system used to arrest a worker in a fall from height. It consists of an anchorage, connectors, suspension trauma device and a body harness and may include a lanyard, deceleration device, lifeline or suitable combinations of these.

Platform/Podium Ladder – A ladder with a deck designed to hold a person, providing three- or four-sided protection and used to facilitate activities above the walking/working surface. (See Figures 2 and 3)



Figure 2: Three-Sided Platform/Podium



Figure 3: Four-Sided Platform/Podium

Professional Engineer – An individual who has fulfilled education and experience requirements and passed rigorous exams that, under South Dakota State licensure laws, grant the authority to sign and seal engineering plans.

Qualified Engineer – An individual with an engineering degree from an accredited university with the knowledge and demonstrated ability to design non-commercial equipment.

Qualified Person – A person who, by possession of a recognized degree, certificate or professional standing, or who by extensive knowledge, training and experience has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work or the project.

Risk – Potential to cause harm or damage to a person, property or environment.

- Low Risk: General tasks performed on a normal daily basis.
- High Risk: Tasks with an elevated potential to cause harm.

Scissor Lift – a mobile scaffold work platform that moves only vertically to position personnel.

Self-Retracting Lanyard (SRL) – A deceleration device containing a drum-wound line which can be slowly extracted from, or retracted into, the drum under slight tension during normal worker movement and which, after onset of a fall, automatically locks the drum and arrests the fall.

Suspension Trauma – Unconsciousness and/or other symptoms caused by remaining suspended in a fall arrest harness for an extended period.

Suspension Trauma Device – Device designed to help a worker overcome the potential negative health impacts of suspension trauma.

Walking/Working Surfaces – Any horizontal or vertical surface on or through which a person walks, works or gains access to a work area or workplace location.

Warning Line Systems – A means of delineating an exposed opening.

Work at Height – Activities performed above walking/working surface where fall from height hazards exist.

Work Alone – When a worker cannot be seen or heard by another person.

4.0 Responsibilities

4.1. Department Directors

- 4.1.1. Ensure that fall protection requirements are incorporated into designs for new and retrofitted equipment as well as future and existing structures where known or predictable fall from height hazards are expected to occur.
- 4.1.2. Ensure general fall rescue plans are established to cover activities if workers are left in a suspended position.

4.2. Project Managers

- 4.2.1. Ensure that all contractors meet the requirements of this standard.
- 4.2.2. Verify that the contractors and subcontractors have a written fall rescue plan in place before any worker is exposed to a fall from height hazard.
- 4.2.3. Verify that fall hazard training has been completed for contractor workers who may be exposed to a fall risk.
- 4.2.4. Obtain information from the contractor regarding fall prevention methods that the contractor will follow while engaged in work at height activities.

4.3. Supervisors

- 4.3.1. Identify activities that present a fall risk to workers.
- 4.3.2. Ensure workers are provided with proper fall protection personal protective equipment (PPE). Fall arrest PPE must include a suspension trauma device.
- 4.3.3. Ensure that fall protection equipment inspections are performed.
- 4.3.4. Ensure that when fall from hazards exist, the worker shall not work alone.
- 4.3.5. Monitor workers while working at height to ensure processes are being followed and controls are in place.
- 4.3.6. If there is a potential for a fallen worker to be in a suspended position, a fall rescue plan must be incorporated into the work planning and control process. See ESH-2000-S-001 Work Planning and Control Standard.

4.4. Environment, Safety, and Health (ESH) Department

- 4.4.1. Provides consultation on fall protection requirements, assessments, and rescue plans to departments when requested.
- 4.4.2. Determines applicable standards, precautions, and training.
- 4.4.3. Develops and updates fall prevention training.
- 4.4.4. Validates external training.

4.5. Workers

- 4.5.1. Recognize areas and tasks that require fall protection/prevention use.
- 4.5.2. Perform pre-use inspection of any fall protection systems.
- 4.5.3. Are never to work alone when a fall at height hazard exists.

5.0 Instructions

5.1. Education and Training Requirements

- Any person(s) involved in work activities and exposed to a fall hazard must be trained and made aware of the risk and methods of fall prevention. At a minimum, the training shall include:
 - Recognition of slips, trips and fall hazards.
 - The correct way to use, inspect, and maintain fall protection systems.
 - Responsibilities of personnel and the employer.
 - Use of suspension trauma devices.
 - Recognition of suspension trauma exposure.
 - Fall arrest rescue/recovery methods/equipment and precautions.
- When underground waiting for the cage, workers should stay 25 feet from the shaft to protect against falling material.

5.2. Attending Persons

- Whenever a worker could fall from height, that worker shall not work alone, but shall be attended by one or more workers who can act to rescue or summon help to aid in a rescue. The attending person(s) shall remain within the immediate area, with the ability to both see the person working at heights and to hear their calls for help, if necessary, of the worker at risk.

5.3. Fall Rescue Plan

- A fall rescue plan must be included in the work planning and control process (i.e. ESH-2000-F-002 Job Hazard Analysis or IMS-T-752-009 SDSTA Standard Operating Process Template). Fall rescue plans shall include rescue procedures, fall rescue devices to be used and methods for a timely rescue to prevent the consequences of suspension trauma. Workers using fall arrest are to be informed of the method used for fall rescue prior to work from height being performed.

5.4. Fall Protection Systems

- All fall protection systems shall meet Occupational Safety and Health Administration (OSHA) standards and must be inspected prior to use.
- Guardrail Systems
 - Guardrails are engineered systems which provide fall from height protection from an exposed opening. The top rail height, or equivalent guardrail system members, are 42 inches, plus or minus three inches, above the walking/working surface (See Figure 4). The top edge height may exceed 45 inches, provided the guardrail system meets all other criteria.
 - For permanent guardrail installations within a building designed for occupancy, the guardrail design may be predicated on an applicable building code.
 - For non-rigid Guardrail Systems, e.g. synthetic or wire rope, force-multiplying effects must be considered (See Figure 5).

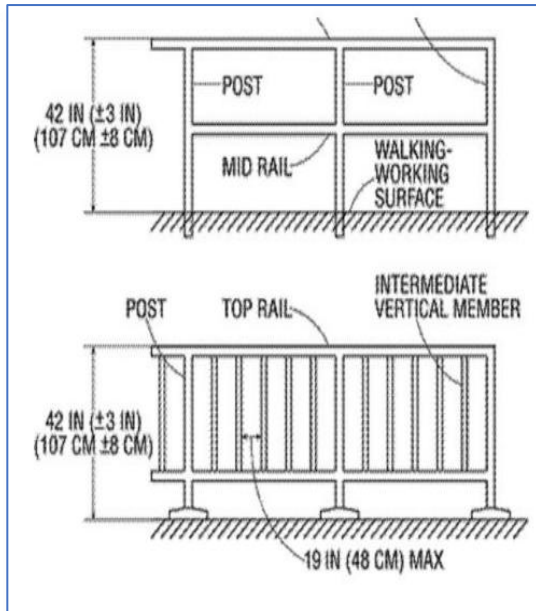


Figure 4 - Guard Rail Systems Diagram

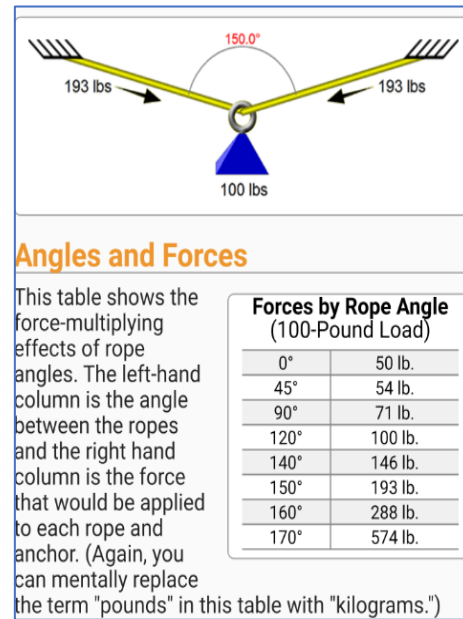


Figure 5 – The force-multiplying effects of rope angles

- Covering of Floor Openings
 - Unprotected floor openings may utilize a cover to prevent falls.
 - Floor coverings must meet the following criteria:
 - ◆ Secured when installed to prevent accidental displacement by environmental factors, equipment or personnel and be strong and durable enough to withstand at least twice the maximum load anticipated to cross over the cover.
 - ◆ All covers shall be color coded, or they shall be marked with the word “HOLE” or “COVER” to provide warning of the hazard. This does not apply to manhole covers or steel grates which provide protection equal to that of the normal working surface.
- Personal Fall Arrest Systems
 - Personal fall arrest systems shall be determined by a qualified person. System components may consist of anchorage, connectors, body harness, deceleration device, lifeline, suspension trauma device or combinations thereof (See ESH-7000-A-004 Technical Requirements for Personal Fall Arrest Systems).
 - Fall Arrest Systems shall be utilized within six feet of the shaft when gate is open, and cage is not at station exposing an open shaft.
- Fall Restraint Systems
 - Body harness systems shall be configured so that an employee cannot be exposed to the fall from height hazard and shall be provided with secure anchorage.
 - Fall restraint lines must be capable of sustaining a tensile load of at least 3,000 pounds.

- Requirements for snap hooks, D-rings and other connectors are the same as detailed in Technical Requirements for Personal Fall Arrest Systems.
- Warning Line Systems
 - Warning line systems may be used as a method of demarcation to supplement fall protection, but at no time shall they be used as a sole control of providing fall protection.
- Initial Testing, Certification, and Inspection of Fall Arrest and Fall Restraint System Components
 - Commercially manufactured equipment - any initial testing, certification, and/or inspection of components of fall arrest and fall restraint systems shall be performed in accordance with prescribed methods and schedules of the manufacturer.
 - Non-commercially designed equipment - shall be designed by a qualified engineer or professional engineer and meet the anchorage requirements. Installation and testing of site-specific anchor points shall be performed by a competent person. Documentation of testing (e.g. pull tests) or ratings of individual components shall be affixed to the component in a manner that informs the user of the rating and/or required inspection.

5.5. Walking/Working Surfaces and the Prevention of Slips, Trips, and Falls

- Walking/working surfaces shall be inspected regularly and as necessary and be maintained in a manner to prevent slips, trips and falls. Hazardous conditions shall be promptly corrected or repaired. If correction or repair cannot be made immediately, personnel shall be prevented from using the walking/working surface until the hazard is corrected. When any correction or repair involves the structural integrity of the walking/working surface, a qualified person must perform or supervise the correction or repair.
- Personnel shall be trained in the recognition of trip hazards associated with underground rail and switches, rail stops, hoist conveyance access, uneven surfaces, etc.

5.6. Working at Height

- Aerial Lifts
 - Anyone working from an aerial lift must wear a personal fall restraint system or SRL following manufacturer's recommendations.
 - Fall protection must be attached to the manufacturer's designated anchor point.
- Scissor Lifts
 - When working from a scissor lift equipped with guardrails that meet the requirements in section 5.4, additional fall protection is not required unless specified in the manufacturer's operating instructions.
- Scaffolding
 - When erecting or working from scaffolding, all requirements in OSHA 1926 Subpart L must be followed.
- Ladders
 - Ladders shall meet the requirements of OSHA 1926.1053 (Subpart X) and OSHA 1910.23 (Subpart D). Prior to using a ladder, the following shall be considered:

- ◆ Alternative methods, such as platform/podium ladder, scaffolding, scissor lift, or aerial lift.
- ◆ Fall protection is required when working from a standard ladder at a height greater than four feet.
- ◆ Fall protection is required when working from the platform of a three-sided podium ladder at a height greater than six feet.
- ◆ Additional fall protection is not required when working from a four-sided podium ladder.
- Fixed ladders shall be designed in accordance with OSHA 29 CFR 1910.23(d) and used only in the manner the ladder is designed.

5.7. Personal Fall Protection Equipment Inspection

- All components of a personal fall arrest system including anchorages, harnesses, lanyards and lifelines, shall be visually inspected by a competent person before each use. In addition, a competent person shall inspect all mobile anchor devices, fall arrest harnesses and lanyards every 12 months and have the inspection documented. If the equipment is found to be deficient, it shall be removed from service immediately. All components of a personal fall arrest system that have been subjected to a fall shall be removed from service and properly disposed of.

6.0 Documented Information/Related Document

- 6.1.** ESH-2000-S-001 Work Planning and Control Standard
- 6.2.** ESH-2000-F-002 Job Hazard Analysis
- 6.3.** ESH-7000-A-004 Technical Requirements for Personal Fall Arrest Systems
- 6.4.** IMS-T-752-009 SDSTA Standard Operating Process Template
- 6.5.** 29 CFR 1910, Subpart D (Walking-Working Surfaces)
- 6.6.** 29 CFR 1910, Subpart F (Powered Platforms, Manlifts, and Vehicle-Mounted Work Platforms)
- 6.7.** 29 CFR 1910, Subpart I (Personal Protective Equipment)
- 6.8.** 29 CFR 1926, Subpart M (Fall Protection)
- 6.9.** 29 CFR 1926, Subpart L (Scaffolds)
- 6.10.** 29 CFR 1926, Subpart X (Stairways and Ladders)