Minimum Performance Criteria for Personal Fall Protection Equipment - ISA Administered Tree Climbing Competitions

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Contents

Foreword

This ‘Minimium Performance Criteria for Personal Fall Protection Equipment’ document has been prepared by the Technical Advisory Committee (TAC) of the International Tree Climbing Competition (ITCC) under the administration of the International Society of Arboriculture (ISA).

The TAC’s purpose is to support both the ITCC Operations Committee and ITCC Rules Committee regarding current international best practices, industry regulations and the use of equipment and systems. The TAC also communicates information to the ISA Safety Committee.

The authority of this document is limited to the realm of ISA administered tree climbing competitions (TCC) and specifies the performance required for fall protection equipment used by participants at these events. Meeting the specified performance is not a requirement for a component, assembly or system to be traded, nor do the stated tests or performance supersede the requirements of local, national, regional or any other legislation.

Introduction

Industrial tree climbers use a wide variety of techniques and equipment to ascend in to, work position on and within, and egress from the canopies of trees. The equipment should be ergonomic, protect against falls, offer comfortable support and allow for changes in position. It is essential that a fall protection system is employed whenever the potential to fall exists. Generic components of fall protection systems include safety lines, rope adjustment devices, connectors and sit and full body harnesses. National, regional and other legislation may apply to the fall protection equipment selected by employers and the self-employed for use at work.

The International Society of Arboriculture (ISA) administer Tree Climbing Competitions (TCC) in a number of countries as well as a number of international events such as the Asia Pacific TCC, European TCC, North American TCC and International TCC. Amongst many other objectives, TCC's seek to create an environment in which safe and efficient industrial tree climbing techniques and equipment can develop, thereby showcasing the best of international work practices which others may then choose to adopt at work.

As a result of this wide international coverage, it has been necessary to develop a single standard that seeks to:

- Outline suitable and sufficient performance and test methods for the fall protection equipment used at TCCs;
- Allow all TCC climbers to select from the same palette of currently available equipment;
- Clarify the performance requirements for those wishing to introduce new or innovative components, assemblies and systems;
- Provide equal opportunities for equipment and techniques regardless of country of origin;
- Accommodate national and regional preferences in technique and equipment choices; and
- Facilitate the development of equipment and the evolution of techniques for safe and efficient tree climbing operations.

Scope

This ISA document applies to fall protection components, assemblies and systems employed during tree climbing operations at ISA administered Tree Climbing Competitions. It specifies the performance, test methods and information required of fall protection equipment employed during ascent, work positioning and egress operations by a single user. The standard does not apply to fall protection equipment used for restraint, fall arrest or rescue scenarios with a two person load.

General Requirements

Compatibility
A component shall be compatible with its' neighbour(s). Components shall have the capacity to perform reliably to specification with defined neighbours, in the chosen environment, without adaption, modification and undesirable effect.

Configuration
The configuration of assemblies and systems shall be defined to facilitate the assessment of performance.

Release prevention mechanism
Components and assemblies that perform the function of a rope adjustment device shall have a mechanism to prevent the release of the specified diameter(s) of safety line from being released accidentally during use.

Edge design
Hardware components shall be free from sharp or rough edges that have the potential to injure the user or cause damage to other components of the fall protection system.

Wet (and other) performance
Components, assemblies and systems shall meet the specified performance in the climatic conditions likely to be encountered in their working environment and those prevailing on the day(s) of competition.

Marking and information
Components, assemblies and/or systems shall be accompanied by sufficient information to allow traceability to the manufacturer, product name, size class and user instructions.

Descent - control and speed
A climber shall be able to regulate the speed of descent during work positioning and rescue operations such that suitable and sufficient control is demonstrated.

Performance Specifications

Connectors, Pulleys and Rings

Shall have a minimum breaking strength of 22kN or greater when new, and shall meet the required performance when configured as part of a system.

Connectors shall be well matched to the chosen configuration and have:

- Self-closing gate and self-securing mechanism; or
- Manual closing gate and threaded securing mechanism.

Connectors, Pulleys and Rings shall be configured so that correct compatibility with neighbouring components is consistent.

See Appendix 3a for details of connector, pulley and ring test procedures.

Harnesses

Harnesses shall be capable of withstanding the following loading in each configuration anticipated and approved by the manufacturer, and any configuration deemed possible/probable by the Head Technician:

- a static force of at least 15kN for at least 3 minutes on all approved fall protection attachment points;
- a dynamic force generated by a steel mass of at least 100kg falling at least 1m applied to all approved fall protection attachment points.

Harnesses must be accompanied by:

- verification of the minimum performance criteria from an independent notified testing body; and
- evidence of manufacture under a quality assurance scheme that ensures consistency.

See Appendix 3b for details of harness test procedures

Equipment for Ascending

Ropes used for ascending shall be 10mm in diameter or greater, with a minimum breaking strength of 22kN when new. Termination and knotted strengths shall be at least 15kN.

Ascent techniques should limit potential fall distance to a maximum of 50cm (20inches).

All systems used for ascent shall be capable of withstanding the following loading in each configuration anticipated and approved by the manufacturer, and any configuration deemed possible/probable by the Head Technician:

- a static force of at least 4kN for at least 3 minutes (See Appendix 3c for details of the static test protocol); and

- a dynamic force generated by a solid steel mass of at least 100kg falling at least 1m. (See Appendix 3c for details of the dynamic test protocol).

Ascent anchors are regularly selected from a distance i.e. remotely. A consequence is that the chain of fall protection components from ground to anchor is often difficult to assess visually. Because of the inherent risk associated with the adjustment of remotely selected ascent anchors, ascent systems shall have the ability to dissipate energy when arresting a fall, such that the deceleration experienced by the climber from a 2m vertical fall is no greater than 6g e.g. a 100kg climber experiences no more than 6kN. Rope, connection textiles, energy absorbers or other PPE components may be employed to dissipate energy.

(See Appendix 3c for details of the dynamic test protocol).

Equipment for Work Positioning (including Mid Line Anchor Assemblies)

Climbing lines for work positioning systems shall be 11mm in diameter or greater. Work positioning lanyards shall be 10mm in diameter or greater. Both shall have a minimum breaking strength of at least 22kN when new and a knotted or termination strength of at least 15kN.

Friction Hitch cords for moving rope applications and those which support the entire system load shall be 8mm diameter or greater. Friction Hitch cords for stationary applications, where the load applied to the hitch is approximately half the system load, shall be 6mm diameter or greater. Friction hitch cord shall be manufactured from material(s) suitably resistant to the abrasion and temperatures experienced during work and rescue scenarios.

Work positioning techniques should limit potential fall distance to a maximum of 50cm (20inches).

All work positioning systems shall be capable of withstanding the following loading in each configuration anticipated and approved by the manufacturer, and any configuration deemed possible/probable by the Head Technician:

- a static force of at least 15kN for at least 3 minutes (see Appendix 3d for details of the static test protocol); and
- a dynamic force generated by a solid steel mass of at least 100kg falling at least 1m. (see Appendix 3d for details of the dynamic test protocol).

Rope Adjustment Devices

Rope adjustment devices may be applied at a mid point to the safety line, or threaded on to the end of the safety line.

All rope adjustment devices must grab reliably on the indicated range of approved diameters of climbing lines. They shall be capable of withstanding the following loading in each configuration anticipated and approved by the

manufacturer, and any configuration deemed possible/probable by the Head Technician:

- a static force of at least 4kN for at least 3 minutes (see Appendix 3e for details of the grab test protocol); and
- a static force of at least 4kN, applied five times in succession after the device has been progressed along the rope at least 50cm (see Appendix 3e for details of the successive grab test protocol) .

It must be possible to operate rope adjustment devices so that their performance is controlled, reliable and predictable under normal work and rescue loads.

Glossary and Definitions

Anchor
The physical location selected to support a load. Anchors must be of suitable and sufficient strength for both the intended loading scenario, and any foreseeable unanticipated scenario e.g. a 'pick off' rescue where the forces may be more than double those of scenarios involving a single climber. Special consideration must be given to the ability of the anchor to tolerate lateral loadings, as trees are often poorly adapted to such forces.

Anchor Device
A component, or an assembly of components, that allows connection to one or more anchor. PPE anchor devices employed by tree climbers might more accurately be called a **'**Mobile Remotely Retrievable Anchor Device'
Example of relevant standard(s): EN795B

Assembly
A collection of two or more components.

Backup
A standby or reserve fall protection system.

Compatible
Components which are consistently capable of performing to specification when combined together in defined configuration(s). A component may have more than one neighbour.

Competent
Possessing the requisite qualifications, experience and skills to perform a task.

Competent Person
A Competent Person is a member of technical personnel who can demonstrate that they have sufficient professional or technical training, knowledge, actual experience, and authority to enable them to:

- carry out their assigned duties at the level of responsibility allocated to them;
- understand any potential hazards related to the work (or equipment) under consideration;
- detect any technical defects or omissions in that work (or equipment), recognise any implications for health and safety caused by those defects or omissions; and
- be able to specify a remedial action to mitigate those implications.

Component
A constituent element of a system

Configuration
A collection of parts where the relative organization of components is defined.

Configured strength
The minimum breaking strength of a component, assembly or system when in use. A Safety Factor should be applied to Configured Strength to generate a Safe Working Load.

Connector
A safety component that can be opened and secured in a closed position. PPE connectors permit the user to attach to/from a fall protection system. Connectors used in tree climbing operations shall have a minimum strength of 22kN when new and:

- a self-closing gate and self-securing mechanism; or
- a manual closing gate and manual securing mechanism.

Example of relevant standard(s): EN362, EN12275, ANSI Z359.1(07)

Dynamic Rope
Synthetic cordage with load bearing elements that exhibit high elongation under load which have the capacity to dissipate energy and reduce impact forces when used as a component in a fall protection system.
Example of relevant standard(s): EN 892

Energy Absorber
A component of a lifting system designed to dissipate energy when arresting a falling mass, such that the forces experienced by the load, lifting system and the supporting structure are reduced.

Fall Arrest
A personal fall protection technique with the following key features:

- a fall that is catered for during work planning e.g. risk assessment; specific equipment is specified for the task (such as a full body harness with sternal and dorsal attachment points);
- a Clear Zone must be present i.e. impact is not made with the structure or other objects e.g. the ground
- a capacity in the fall protection system to dissipate energy away from the climber, normally by gradual deceleration i.e. force generated in arresting the fall is kept below 6kN(6G) by energy absorbing elements.

A fall arrest system comprises an energy absorber attached to a full body harness by a thoracic attachment. It is intended to arrest a fall to stop a person hitting the ground or other obstacles and is designed to limit the impact force of the fall and retain the user 'upright' in the harness.

Fall Protection System
A collection of performance assured components which, when used correctly, combine to either limit the potential for a fall or minimize the consequences of a fall.

g (acceleration)
g is the rate of acceleration induced by the presence of gravity upon an object i.e. 9.81ms^2 on planet earth. It is also known as the 'acceleration of free fall' because it defines the increase (or rate of change) of speed of a falling object per second (in a vacuum). g-force is a term used to describe the comparative rate of acceleration or deceleration relative to gravity i.e. expressed as multiples of 9.81ms^2. In this sense, a deceleration rate of 49.05 ms^2 is equal to 5g because 5 x 9.81 = 49.05.

When a falling mass (such as a person) is arrested, g may be calculated by dividing the force generated from arresting the fall by the force generated due to gravity acting upon the mass at rest e.g.:
6kN arrest force ÷ 1kN weight (100kg mass x g) = 6g;
6kN arrest force ÷ 0.6kN weight (60kg mass x g) = 10g;
6kN arrest force ÷ 1.2kN weight (120kg mass x g) = 5g.

Harness
An assembly of load bearing, comfort and adjusting elements which fit around the body to support it in a hanging position and allowing the connection of other components. A work positioning sit harness normally consists of a pelvic (ventral) and side attachment points and leg loops.
Example of relevant standard(s): EN 358, EN 813, EN 361.

Helmet
Headwear primarily intended to protect the upper part of the wearers' head against hazards which might occur at work. Common elements include the shell, protective padding, comfort padding, adjustable retention system and chin strap.
Example of relevant standard(s): EN397 (Industrial), EN12492 (Mountaineering), EN 14052 (Industrial).

Impact Force
An instantaneous force (measured in kN or daN). Commonly experienced when arresting a falling mass.

kN
The newton (N) is the SI unit for force. It is equal to the amount of force required to accelerate a mass of one kilogram at a rate of one meter per second squared (1ms^2).

1N = 0.22481lbF. 1000N is normally abbreviated to 1kN, which is approximately equal to 102kgF/225lbF. 10N is normally abbreviated to 1daN which is approximately equal to 1kgF/2.25lbF

Lifting system
An assembly of components employed to lift, lower or hold a load.

Load
The mass to be lifted, lowered or held in place. A person is considered to be a load.

Low Stretch Rope
Synthetic cordage with load bearing elements that exhibit low elongation under load, and with prescribed performance criteria.
Example of relevant standard(s): EN 1891 Type A

Minimum Breaking Strength (MinBS)
The lowest load at which an item of lifting equipment can be expected to fail when new.

Moving Rope System
A fall protection system in which the rope adjustment device advances along a moving line. Doubled rope technique (Drdt) or running rope systems are examples of Moving Rope Systems (contrast with Stationary Rope System)

Peak Force
The highest force generated during a loading episode. Measured in kN or daN.

Personal Protective Equipment (PPE)
Personal Protective Equipment. Any device or appliance designed for protection against health hazards. In Europe all equipment for working at height is categorised as TYPE III OR COMPLEX PPE, that is to say it protects against mortal danger. Type III equipment must:

- undergo independent type testing, usually to European standards or NORMS;
- have appropriate technical and user instructions in the language of the country of sale; and
- be produced under an independently verified quality system (e.g. ISO 9001) or be subjected to annual recertification.

Potential Fall Distance (PFD)
The potential vertical distance through which a climber could pass, before a fall protection system arrests a fall.

Quarantine
1) The act of removing from service of a component, assembly or system to allow for further assessment, repair, testing and/or gathering of information. The equipment should be clearly labeled or marked as quarantined and placed in isolation so that it cannot be introduced into service inadvertently. Following a further Thorough Examination by a Competent Person, the item may (when deemed safe to do so) be either reintroduced into service or otherwise disposed of.
2) A physical location (e.g. cupboard, demarcated area of floor or container) where work equipment can be held in isolation, so that it cannot be introduced into service inadvertently.

Quality Assurance Scheme
The planned, systematic and monitored actions that are implemented as part of a quality management system, with the objective of meeting defined performance. It requires the systematic gathering of data, comparison with defined (internal and/or external) standards and the monitoring of processes which, when combined with a formalized feedback system, seek to ensure performance and prevent error. A good quality management scheme promotes a customer focus, continual improvement, the empowerment of people and a factual approach to decision making.
Example of relevant standard(s): ISO 9000 series.

Redundant/Redundance
A component, assembly or system that can be removed without consequence/loss of strength. In the context of a fall protection backup: a system which is superfluous until required.

Risk Assessment
A step in a risk management procedure. The determination of hazard, risk levels, what and who is at risk and the control measures required to minimize risk to acceptable levels.

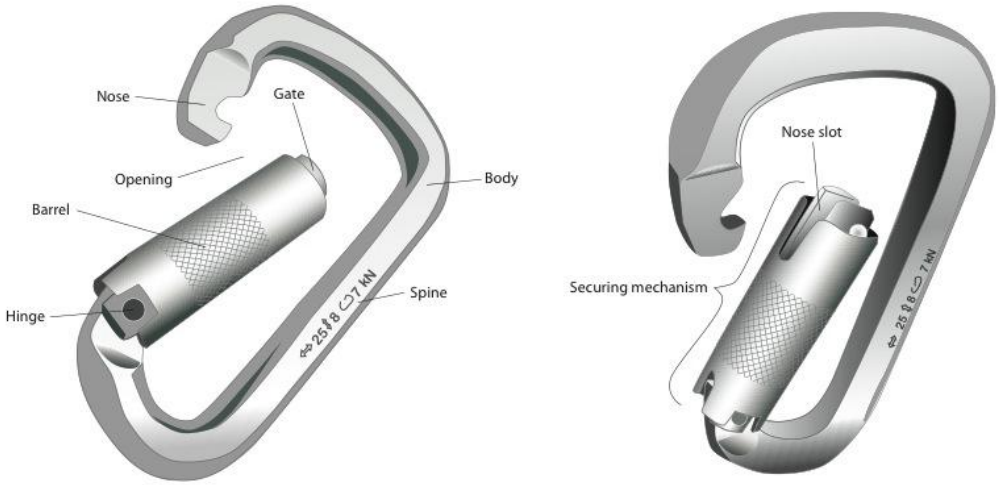
Rope Access
A method of using ropes, in combination with other devices, by which a user descends or ascends a working line to get to or from the workplace, and for work positioning, while further protected by a safety line, such that both lines are connected to the user's harness and separately secured to a reliable anchorage in such a way that a fall is prevented or arrested.

Rope Adjustment Device
A device used to aid progression up or down a rope (or both), or to maintain position.
e.g. friction hitch, descender, ascender, multi purpose mechanical device.
Example of relevant standard(s): EN341, EN567, EN12841, EN795.

Safe Working Load
The maximum load (as certified by a competent person) that an item of lifting equipment should be subjected to under particular service conditions. The SWL, therefore, may be lower than the WLL.

Safety Factor (or design factor)
The ratio between the MBS and the WLL/SWL.

Self Closing Gate
A gate which moves unaided to the closed position when released from any open position



Self Securing Mechanism
A mechanism which secures the location of the gate in the closed position. All securing actions of the mechanism must operate without assistance when released by the operator. Self securing mechanisms shall require at least two different manual actions before the gate may be opened.

Self securing mechanisms for karabiners shall pass three tests at ITCC equipment inspection:

- Release gate from fully open position;
- Release gate from an open position 10mm from nose; and

- Release gate from a position alongside the mid point of the nose with the mechanism. If there is tolerance in the hinge rivet or a spring bias in the securing mechanism, allow the gate and/or mechanism to contact the nose before releasing the mechanism.

In all tests, release the mechanism without bias. For the securing mechanism to function correctly, it must reliably attain the fully closed and secured position in each test.

Static Rope
Synthetic cordage with load bearing elements that exhibit negligible extension under load.

Stationary Rope System
A fall protection system in which the rope adjustment device moves along a stationary working line (contrast with Moving Rope System)

System (fall protection)
The collection of fall protection components that connect a climber to an anchor.

Thorough Examination
The objective assessment of performance critical lifting equipment (including fall protection equipment), whereby an informed judgement is made by a Competent Person to determine whether the equipment is:

- fit to be retained in service;
- quarantined; or
- removed from service.

All lifting equipment deteriorates during use and should be thoroughly examined so that deterioration can be detected in sufficient time to allow remedial action to be taken. The frequency of examination is determined by:

- equipment history;
- the frequency of use;
- the rate of wear and tear during use;
- any applicable legislation; and
- the occurrence of exceptional circumstances.

The potential risks arising from the failure of the lifting equipment will determine how thorough the examination needs to be. The extent of the Thorough Examination will depend on:

- an assessment of the risks based on the type of equipment and the work it performs;
- the location where it is installed;
- how it is to be used; and
- the environment in which it is employed.

Thorough Examination prior to the first use of new equipment is recommended. Equipment testing may be required as part of the Thorough Examination process.

Threaded Securing Mechanism
A manual securing mechanism that requires at least four (4) complete rotations of the screw motion gate from the fully screwed up position to disengagement of the threads. There shall be a clearly visible indication if the gate and mechanism are not in the fully secured position e.g. exposed threads or a region of contrasting colour. Additional securing features may be installed by the manufacturer or required by the Head Technician.

Working Load Limit
The maximum load an item of lifting equipment is designed to raise, lower or suspend (as guaranteed by the manufacturer at the point of sale). This does not account for particular service conditions that may affect the final rating of the equipment.

Work Positioning
A work technique which enables the user to:

- work supported in tension or suspension by personal fall protection equipment in such a way that a fall is prevented or restricted;
- achieve a place of work with precision and efficiency;
- relocate to subsequent work positions; and

- make efficient and safe egress from the site of work.

Work Restraint
A work technique whereby the user is prevented by personal and/or collective fall protection equipment from reaching any location from which a fall from height exists.

Appendix 1. Test apparatus.

Appendix 2. Conditioning of test samples.

Appendix 3. Performance specifications for personal fall protection systems.

Appendix 4. Summary of Fall Protection Standards by Product Category and Region

Product Category	Australia and New Zealand	Canada	Europe	United States
Accessory Cord	AS4142.3	CSA 4.1	EN564	
Anchor device			EN795	ANSI Z359.1 ANSI Z359.3 ANSI Z359.12
Backup device			EN12841	
Connector	AS/NZS 1891	Z259.12-11	EN362 EN12275	ANSI Z359.12 ANSI Z133-2011-8.1.9 ANSI Z133-2011-8.1.10 ANSI Z133-2011-8.1.11 ANSI Z133-2011-8.1.12
Descender	AS/NZS 1891		EN341 EN12841	ANSI Z359.4 NFPA 1983
Energy absorber	AS/NZS 1891		EN355	ANSI Z359.1
Harness	AS/NZS1891.3: 1997		EN358 EN361 EN813 EN12277	ANSI Z359.3 NFPA 1983? ASTM 887? proposed) ANSI Z133-2011-8.1.5 ANSI Z133-2011-8.1.6
Helmet	AS1800:1998 AS1801:1997		EN397 EN12492 EN14052	ANSI Z89.1 ANSI Z133-2011-3.4.4
Lanyard	AS/NZS 1891		EN354 EN358	ANSI Z359. .3 ANSI Z133-2011-8.1.8 ANSI Z133-2011-8.1.28
Mobile Fall Arrester Device	AS/NZS1891.3: 1997	Z259.1	EN353-1	ANSI Z359.1
Pulley			EN12278	NFPA 1983
Rope - dynamic	AS4142.3		EN892	UIAA 101 ANSI Z133-2011-8.1.3 ANSI Z133-2011-8.1.5 ANSI Z133-2011-8.1.16 ANSI Z133-2011-8.1.17 ANSI Z133-2011-8.1.18
Rope – low stretch	AS4142.3		EN1891	C11801-08
Rope Clamp	AS/NZS 1891		EN567 EN12841	NFPA 1983
Sling and Loop			EN354 EN566 EN795	
Work positioning system	AS/NZS 1891		EN358	ANSI Z359.3 ANSI Z133-2011-AnnexA

Appendix 5. List of Fall Protection Standards by Region

Australia and New Zealand TBD

Canada- TBD

Europe

EN 341:2011	Personal fall protection equipment – Descender devices for rescue
EN 353-2:2002	Personal protective equipment against falls from a height Part 2: Guided type fall arresters including a flexible anchor line
EN 354:2010	Personal fall protection equipment - Lanyards
EN 355:2002	Personal protective equipment against falls from a height – Energy absorbers
EN 358:2000	Personal protective equipment for positioning and prevention of falls from height – belts for work positioning and restraint and work positioning lanyards
EN 361:2002	Personal protective equipment against falls from a height – Full body harnesses
EN 362:2004	Personal protective equipment against falls from a height - Connectors
EN 397:2012	Industrial safety helmets
EN 564:2006	Mountaineering equipment – Accessory cord – Safety requirements and test methods
EN 566:2006	Mountaineering equipment – Slings – Safety requirements and test methods
EN 567:1997	Mountaineering equipment – Rope clamps – Safety requirements and test methods
EN 795:1997	Protection against falls from a height – Anchor devices – Requirements and testing
EN 813:2008	Personal fall protection equipment – Sit harnesses
EN 892:2004	Mountaineering equipment – Dynamic mountaineering ropes – Safety requirements and test methods
EN1891:1998	Personal protective equipment for the prevention of falls from a height – Low stretch kernmantel ropes
EN12275:1998	Mountaineering equipment – Connectors – Safety requirements and test methods
EN12277:2007	Mountaineering equipment – Harnesses – Safety requirements and test methods
EN12278:2007	Mountaineering equipment – Pulleys – Safety requirements and test methods
EN12492:2000	Mountaineering equipment – Helmets for mountaineers – Safety requirements and test methods
EN12841:2006	Mountaineering – Harnesses – Safety requirements and test methods
EN14052:2012	High performance industrial helmets

United States

ANSI/ASSE Z359.0-2007	Definitions and Nomenclature Used for Fall Protection and Fall Arrest
ANSI/ASSE Z359.1-2007	Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components
ANSI/ASSE Z359.2-2007	Minimum Requirements for a Comprehensive Managed Fall Protection Program
ANSI/ASSE Z359.3-2007	Safety Requirements for Positioning and Travel Restraint Systems
ANSI/ASSE Z359.4-2007	Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components
ANSI/ASSE Z359.5-2007	
ANSI/ASSE Z359.6-2009	Specifications and Design Requirements for Active Fall Protection Systems
ANSI/ASSE Z359.7	
ANSI/ASSE Z359.8	Rope Access
ANSI/ASSE Z359.9	
ANSI/ASSE Z359.10	
ANSI/ASSE Z359.11	
ANSI/ASSE Z359.12-2009	Connecting Components for Personal Fall Arrest System
ANSI/ASSE Z359.13-2009	Personal Energy Absorbers and Energy Absorbing Lanyards
ANSI/ASSE Z359.1-1992 (R1999)	Historical Document

Appendix 6. Table of Units

Force					
newton	1N			~0.1kgf	~0.225lbf
decanewton	1daN	10N		~1kgf	~2.25lbf
kilonewton	1kN	1000N	100daN	~102kgf	~225lbf
	4kN	4 000N	400daN	~410kgf	~900lbf
	15kN	15 000N	1 500daN	~1530kgf	~3370lbf
	22kN	22 000N	2 200daN	~2240kgf	~4950lbf

Length					
millimetre	1mm				~0.04”
	6mm				~0.24” (1/4”)
	8mm				~0.31” (5/16”)
	9.5mm				~0.37” (3/8”)
	10mm	1cm			~0.39”
	11mm				~0.43” (7/16”)
	12mm				~0.47”
	12.7mm				0.5” (1/2”)
	25.4mm				1”
	50mm	5cm			~1.97”
	100mm	10cm			~3.94”
	200mm	20cm			~7.88”
	250mm	25cm			~9.84
	500mm	50cm			~19.69”
centimetre	1cm	10mm			~0.39”
metre	1m	1000mm	100cm		~39.4”

Mass					
kilogram	1kg				~2.205lbs
	60kg				~132.3lbs
	100kg				~220.5lbs
	120kg				~264.6lbs