pureSAFETY™
FALL PROTECTION

AN OVERVIEW OF THE ANSI Z359 FALL PROTECTION CODE

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INTRODUCTION

The American National Standards Institute (ANSI) was founded in 1918 (originally the American Engineering Standards Committee - AESC) to standardize development of certain areas of manufacturing, safety, and engineering. Its first major project in 1919 focused on pipe thread dimensions, followed shortly thereafter in 1920 by the ambitious American Standard Safety Code, which sought to synchronize the disparate and confusing nationwide safety laws and standards that served more as an inhibitor to, rather than a facilitator of, jobsite safety. Fast-forward nearly a century and ANSI has expanded its reach into the automotive and aerospace fields, software, electronics, energy, and a host of other industries too numerous to mention here. For those in fall protection, ANSI made its entry into the field in 1992 with the introduction of the ANSI/ASSE Z359.1 American National Standard for personal fall arrest systems in non-construction occupations. In the 25 years since its initial release, the ANSI Z359 body of standards have grown considerably, and have become the backbone for design, testing, and performance for most of

the products used by workers at height around the globe. This document serves as a brief overview of the entire ANSI Z359 standards catalog known as The Fall Protection Code, and highlights the latest revisions of each standard within the code, focusing on product design, testing, and performance. Please refer to the full versions of the standard for complete information. It should be noted that adhering to ANSI standards is voluntary, but the standards reflect the latest findings (via regular revisions) by engineers and industry professionals regarding materials and methods to protect workers at height. However, given the degree of expertise and leadership shown by the ANSI committee, legally-binding regulatory bodies such as OSHA and CSA frequently refer to ANSI standards when creating their own regulations. The following information provides only a summary of the latest, major components of each standard within the Z359 Fall Protection Code. The information is not intended to replace the full ANSI suite of standards, and is based solely on Pure Safety's understanding of the ANSI Z359 Fall Protection Code.

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Z359.0 – 2012

Definitions and Nomenclature Used for Fall Protection and Fall Arrest

Released in 2012, Z359.0 is the dictionary for navigating the other Z359 standards. Like any industry or field, fall protection is rife with technical and not-so-technical terminology. This standard clarifies terms so that fall protection professionals can be as precise as possible regarding product application, design, and intent. Since so many terms ANSI uses come from our colloquial, everyday language, providing their exact definition in relation to fall protection helps to get professionals on the same page, regardless of locale or position within the industry.

Z359.0 is a unique standard in that it is one of only two that are available for free. This standard is essential reading for anyone in or around the fall protection industry, and is available for download on the ANSI website: http://www.asse.org/assets/1/14/Z359_0_2012wm1.pdf

Z359.1-2016

The Fall Protection Code

Z359.1 is the original ANSI fall protection standard, and was released in 1992, reaffirmed in 1999, and revised in 2007. In its original form, Z359.1 established "…requirements for performance, design, marking, qualification, instruction, training, inspection, use, maintenance and removal from service of full body harnesses, connectors, lanyards, energy

absorbers, anchorage connectors, fall arresters, vertical lifelines and self-retracting lanyards." As might be expected, to keep contained the entire suite of requirements in a single standard would be a difficult task.

This turned out to be the case, and shortly after Z359.1 was revised in 2007, ANSI began to release individual standards focused on a narrower scope of the fall protection code. By 2016, the 2007 revision was all but obsolete, its standards having been split into smaller individual standards that provide a greater degree of clarity and direction than the previous all-encompassing Z359.1 standard.

As a result, in August of 2016, ANSI approved the latest revision of Z359.1, which changed its scope from that of a product standard to a sort of "table of contents," for the other individual standards. Z359.1 now only provides basic information on the scope of each standard. Since Z359.1 is no longer a product standard, new products may no longer be marked with the Z359.1 standard, and instead must comply with the individual standard by which they are now governed. This does not mean that products marked with the Z359.1 standard are unsafe or need to be removed from service, just that future products must be marked to the new, product-specific standard.

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Z359.2-2017

Minimum Requirements for a Comprehensive Managed Fall Protection Program

Z359.2 sets the "…minimum requirements of a fall protection program that will enable an employer to identify, evaluate, eliminate, or control fall hazards in the workplace."

This is an employer and end user focused standard that helps ensure employers, when creating a fall protection plan, are as inclusive as possible, and account for all aspects of the plan from record-keeping, training, inspections, and delegation of responsibilities. Inherent in this standard is that it is the responsibility of the employer to create the fall protection plan, and to adhere to the recommendations therein.

Z359.2 defines the duties and responsibilities required of jobsite staff including program administrators, qualified persons, and trainers, and sets minimum training intervals for all staff so that they remain proficient in the use and understanding of fall protection equipment and practices.

Although primarily an administrative standard, Z359.2 does establish some general requirements for fall protection systems. For example, it restricts maximum arrest forces to 1,800 lbs., as well as prohibits travel restraint systems on any roof with a slope over 4:12, preferring fall arrest instead. It also sets minimum required anchorage connector strength based on intended application (for example, 5,000 lbs. for arrest and 1,000 lbs. for restraint), and establishes minimum static load requirements for both certified and non-certified installations.

Lastly, Z359.2 provides guidance on the inspection, maintenance, and storage of fall protection and rescue equipment, their removal from service (if necessary), and managing incident and rescue events. This information is used by program administrators to

generate local policy and procedures based on their specific application that conforms to ANSI standards. Of note is the necessity of contacting local rescue authorities, determining capability limits, and recording and reviewing procedure with the jobsite competent person before posting the written report.

Z359.3-2017

Safety Requirements for Lanyards & Positioning Lanyards

Z359.3 is the first of the Z359 standards that specifically addresses fall protection product design, manufacture, testing, and performance requirements. Z359.3 focuses on lanyards and [work] positioning lanyards only. This is a change from the previous revision of 2007, which focused on positioning and travel restraint systems, and included other components such as rope adjusters, full body harnesses, and positioning harnesses in addition to lanyards and positioning lanyards.

The 2017 revision removes harnesses from its scope, and leaves them to their own Z359.11 standard. Note that shock absorbing lanyards are NOT covered by the Z359.3 standard, even though they may technically be used in travel restraint applications. For information on shock absorbing lanyards, see Z359.13.

Lanyards and positioning lanyards may be made in any length and be constructed from wire rope or any synthetic material, provided they meet the requirements of Z359.3. Any means of adjustment on lanyards shall automatically stop if the adjuster is released. Lanyards must be tested to withstand a static load of 5,000 lbs.; adjustable lanyards must maintain their length when subjected to a load of 1,000 lbs. for a minimum of 1 minute. Lanyards and positioning lanyards shall withstand the forces of a test weight dropped from a height necessary to apply 3,600 lbs. of force or a maximum distance of 4 feet.

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Z359.4-2013

Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems, and Components

Z359.4 is a dense standard addressing rescue systems and their constituent parts. Because rescue systems are composed of equipment whose manufacture and performance is governed by other Z359 standards, ANSI defers to these standards within Z359.4 when appropriate. Please refer to the referenced standards for more detail. The following standards address equipment that may be utilized in rescue systems:

- Connector (Hardware) Components and Elements – Z359.12 – 2009
- Full Body Harness – Z359.1 – 2016
- Rescue Lanyard Component – Z359.1 – 2016
- Rescue Anchorage Connector Components – Z359.1
- Self-Retracting Lanyard with Integral Rescue Capability – Z359.14 – 2014

Z359.4 directly addresses three types of rescue devices not covered by other standards: synthetic rope tackle blocks, descent devices, and personnel hoists.

Synthetic rope tackle blocks are used to manually raise or lower a victim from either a remote location (above, below, or horizontally offset from victim), or as an assisted rescue in which the rescuer accompanies the victim to safety. Rescue (descent or ascent) is controlled manually by the rescuer via a 3:1 minimum mechanical advantage system.

Automatic descent devices are most commonly used in applications where by the victim must be lowered with or without user input. Descender devices automatically limit descent speed to less than 6.6 ft./sec. Descent devices may be capable of single or multiple uses as determined by their potential descent energy rating.

Personnel hoists are often part of a tripod or davit systems and are rated for one

or two-person capacity. Personnel hoists are dedicated lifting/lowering devices and should not be confused with SRL-Rs, whose rescue capability allows them to raise or lower victims. SRL-Rs are governed by the Z359.14-2014 standard.

Z359.6-2009

Specifications and Design Requirements for Active Fall Protection Systems

Z359.6 is an engineer-focused standard that is to be used as a reference during the designing of fall protection systems. It is not a product standard per se, but a set of standards that should be met as engineers solve fall protection problems. Of note is that the standard does not address passive fall protection systems such as guardrails and nets (unless they are to be used as an anchorage for an active system), work positioning systems, or any other equipment that is governed by another Z359 standard. It also does not cover how to determine the structural integrity of an anchor to which an anchorage connector is connected.

The standard also provides a reminder to engineers that an active fall protection system should be the "…last option from the hierarchy of fall protection… other options for employee protection should be considered prior to the employer selecting the use of an active fall protection system." Essentially, this means that solutions that eliminate hazards, prevent access to hazards, or retrain access to hazards should all be considered prior to the implementation of an active system.

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Z359.7-2011

Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems, and Components

Z359.7 establishes the requirements for testing fall protection products to their respective ANSI Z359 standard, including third-party testing or witnessed manufacturer testing. Z359.7 gained prominence as product-specific standards were released and began citing it within individual standards. It's a reasonable position that to make test results meaningful across manufacturers (and to the workers at height who use the equipment) ANSI needed to establish the performance criteria of the test equipment and procedures themselves. An important aspect of Z359.7 is that product testing must be performed at a third-party laboratory, or at the manufacturer's laboratory, either of which must be accredited to ISO 17025 standards. In the case of the latter, and to maintain the objectivity and validity of the tests, ANSI requires that the tests are witnessed by either a third-party representative or a professional engineer.

Manufacturers may only provide for testing new samples of products identical to those available to consumers, and must maintain and make available full testing reports for each product tested. Reports must be available for any product in production, and for 10 years after any product is discontinued. Additionally, manufacturers must establish and maintain a Safety Alert and Product Recall system to notify users of any safety-related notices.

Z359.11-2014

Safety Requirements for Full Body Harnesses

Z359.11-2014 is a straightforward standard focused on the design, performance, and testing of full body harnesses (FHBs). As inferred from the title, body belts that are not attached to a full body harness are not covered by the standard, as they are not an approved solution for active fall protection systems. Full body harnesses that are compliant with this standard must be used with other fall protection equipment that limits maximum arrest forces to 1,800 lbs.

The standard requires full body harness be constructed from webbing a minimum 1 5/8 inches with a minimum 5,000 lbs. breaking strength. It also requires harnesses to include (at a minimum) a dorsal attachment point (D-ring), load bearing sub-pelvic strap, and webbing assembly that minimizes the possibility of releasing the torso.

Harnesses must include a visible fall arrest/impact indicator and at least one lanyard parking attachment.

Given the many different attachment element configurations possible with an FBH, the testing requirements are quite extensive. Each element (dorsal, shoulder, sternal, waist, hip) is tested in a way commensurate with its approved use. In general, attachment elements used for fall arrest (dorsal, frontal, sternal) must be subjected to both dynamic and static tests, and elements used in fall restraint must be subjected to only static tests. Dynamic drop tests shall use a 220 lbs. test torso dropped from a height necessary to generate 3,600 lbs. of force (head first test torso is dropped 24 inches), and 5,000 lb. static strength tests shall pull at a uniform rate of no greater than 2 inches per minute.

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Z359.12-2009

Connecting Components for Personal Fall Arrest Systems

Z359.12 addresses the design, performance, and testing of hooks (all types), carabiners, O-rings, D-rings, adjusters, and other hardware components used in fall protection systems. Of note is that ANSI does not specify or suggest materials from which these components may be made. By focusing on design and performance only, ANSI frees manufacturers to use whatever materials are most suitable for a specific application, an example being the use of di-electric material in harness components that may be subjected to high-voltage conditions. Snap hooks and carabiners must be self-closing and self-locking, and shall require two consecutive and deliberate actions to open, as a means of preventing accidental rollout. Connectors (including D and O-rings) must withstand 5,000 lbs. of force along their major axis (between normal bearing points), and 3,600 lbs. of force on the gate, applied in any direction without the gate separating more than 1/8 inch. Connectors submitted for dynamic testing shall first be abrasion conditioned by suspending the connector, weighted by 2 kg, on a rotating 3/8 inch hexagonal steel bar for 50,000 revolutions. Samples must then be cold-conditioned at -35° C for a minimum of 8 hours. If the connector is made from material other than metal or metal alloys, it shall be subjected to accelerated weather conditioning by exposing it to 2,000 hours of xenon arc light. Connectors are tested by dropping a 220 lb. test weight from a height necessary to generate a maximum arrest force between 5,000 lbs. and 5,405 lbs.

Z359.13-2013

Personal Energy Absorbers and Energy Absorbing Lanyards

Z359.13 addresses the design, performance, and testing of personal energy absorbers and energy absorbing

lanyards used in fall protection systems. Z359.13 classifies personal energy absorbers into two classes: 6-foot free fall and 12-foot free fall. However, it also cautions users that alternate means should be considered before allowing any free fall greater than 6 feet, and that local governing bodies (e.g. OSHA), may require proof of infeasibility before allowing falls greater than 6 feet.

Personal Energy Absorbers shall be made from virgin synthetic material and include a deployment indicator that clearly shows if the absorber has been subjected to an impact. Absorbers (as an individual component or integral with a lanyard) must have a minimum activation force of 450 lbs. and a minimum breaking strength of 5,000 lbs. Adjustable-length lanyards shall maintain their length while being subjected to a load of 2,000 lbs. for a minimum of 1 minute. Dual-leg energy-absorbing lanyards shall be tested in all possible configurations, including as if misused. Personal energy absorbers and energy absorbing lanyards shall arrest the drop of a 282 lb. weight from a height equal to their approved free fall rating (6-foot or 12-foot). 6-foot free fall lanyards shall have a maximum deployment distance of 48 inches, an average arrest force of no greater than 900 lbs., and a maximum arrest force of no greater than 1,800 lbs.

12-foot free fall lanyards shall have a maximum deployment distance of 60 inches, an average arrest force of no greater than 1,350 lbs., and a maximum arrest force of no greater than 1,800 lbs.

Dual-leg energy absorbing lanyards shall be tested with both legs connected, and shall have a maximum arrest force of no greater than 1,800 lbs. Dual-leg lanyards shall also be subjected to a hip test whereby a sample is tested as above, with the unused leg attached to a connector on the test weight via a nylon keeper. If the unused lanyard breaks the nylon keeper, the energy absorbing lanyard shall include a warning label noting to properly secure the unused lanyard leg.

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Z359.14-2014

Safety Requirements for Self-Retracting Devices for Personal Fall Arrest and Rescue System

Z359.14 governs the design, performance, and testing requirements of self-retracting devices (SRDs), including self-retracting lanyards (SRLs), self-retracting lanyards with rescue capability (SRL-Rs), and self-retracting lanyards compatible with leading edge applications (SRL-LEs). It further classifies SRDs into Class A or Class B, based on dynamic performance as determined by deceleration distance, average arrest force, and maximum arrest force. Class A SRLs may allow for a maximum 24" deceleration distance and a 1,350 lb. average arrest force, while Class B SRLs may allow for a maximum 54" deceleration distance and a 900 lb. average arrest force. For SRL-LEs, deceleration limits established by SRL class do not apply when used in LE applications, however must still be determined and communicated by the manufacturer. Z359.14 is an expansive standard, and should be consulted directly for more specific testing and performance criteria.

The locking function of SRDs shall be automatic, and not capable of being overridden. Any energy absorbing capability shall be available throughout the entire working range of the SRD. SRDs shall include a visual impact indicator that must remain visible at the SRDs full lifeline extension. All SRD components shall be protected from corrosion and withstand a 96-hour salt-spray test with no loss of functionality. Lifeline retraction tension shall be between 1.25 lb. and 25 lbs. at any point in the extended range. SRDs designed for leading edge applications (SRL-LEs) shall additionally incorporate an integral energy absorber adjacent to the end of the lifeline that connects to the body support.

SRL-Rs must be able to engage rescue mode an any time without accidental engagement or disengagement. SLR-Rs

shall be capable of raising and lowering to affect rescue, and offer a minimum of a 3:1 mechanical advantage. They additionally shall automatically stop and hold the load in the event rescuer relinquishes control.

Z359.15-2014

Safety Requirements for Single Anchor Lifelines and Fall Arresters for Personal Fall Arrest Systems

Z359.15 governs the design, performance, and testing requirements of single anchor lifelines and fall arresters, commonly referred to as vertical lifeline assemblies (VLAs). VLAs were last addressed by the original Z359.1-2007 standard. Z359.15 provides more comprehensive guidance for manufacturers on all aspects of VLAs. Window cleaning equipment is not covered by this standard.

Both rope and cable lifelines, as well as fall arresters (such as rope grabs), are addressed by Z359.15, and all have specific testing and performance requirements. Rope lifelines must have a minimum breaking strength of 5,000 lbs. and must not elongate more than 10% when subjected to a force of 1,800 lbs. Ropes must also not have knots or splices in the strand bundles, and shall be sufficiently terminated by a splice, stitch, or swage. Cable lifelines, meanwhile, must be a minimum 5/16 inch diameter, have a minimum breaking strength of 6,000 lbs., and shall be terminated by a spliced eye with one swaged fitting, or a return eye with a minimum of two swaged fittings. Fall arresters must automatically lock without any input from the user to engage rope, and require two consecutive, deliberate actions to open. Lanyards integral to fall arresters must be made from synthetic material capable of withstanding a 3,600 lb. load, be terminated by a splice or stitch, and include a visible fall arrest/load indicator.

Dynamic testing is performed by connecting the lifeline to the test

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structure in a manner that either bypasses or removes the energy absorbing component. The test weight is dropped from the maximum height allowed by the fall arrester, and the total fall distance must not be greater than 11 ft., while the average arrest force and maximum arrest force must not exceed 900 lbs. and 1,800 lbs., respectively. A residual strength test is then performed. The dynamically tested system shall withstand a load of no less than 660 lbs. for a minimum of 1 minute, and the fall arrester shall not move more than 4 inches. The system shall then withstand a load of 1,800 lbs. for 1 minute.

Z359.16-2016

Safety Requirements for Climbing Ladder Fall Arrest Systems

Z359.16 governs the design, performance, and testing requirements of vertically oriented Climbing Ladder Fall Arrest Systems (CLFAS). This standard is poised to take on a greater degree of prominence as building owners become compliant with the 2017 update of the OSHA 1910 General Industry regulations, which mandates ladder safety systems on all fixed ladders over 24' by 2036. The carrier component (whether flexible

or rigid) of a CLFAS must accommodate a minimum of two workers (the second to facilitate rescue), include cable guides at a maximum spacing of 40', and assume a minimum load of 2,700 lbs. will be transferred to the carrier in the event of a fall. If the CLFAS is designed to accommodate more than two workers, an additional 310 lbs. of applied load per user shall be added. Carrier sleeves (also called grabs) shall be auto-locking, include an anti-inversion feature to prevent installing the sleeve upside down, and shall require two separate actions to be installed or removed from a carrier component.

Static testing is conducting by exposing the system to a minimum 3,600 lb. load for at least 1 minute. If the carrier extends above the top of the climbing ladder, a second test is required with the carrier sleeve positioned at the maximum possible height allowed by the extension. Dynamic testing requires the CLFAS system to withstand the drop of a 282 lb. weight from the maximum height allowed by the carrier linkage, with an average arrest force less than 1,350 lbs, and a maximum arrest force of less than 1,800 lbs. Vertical displacement of the test weight shall not exceed 39".

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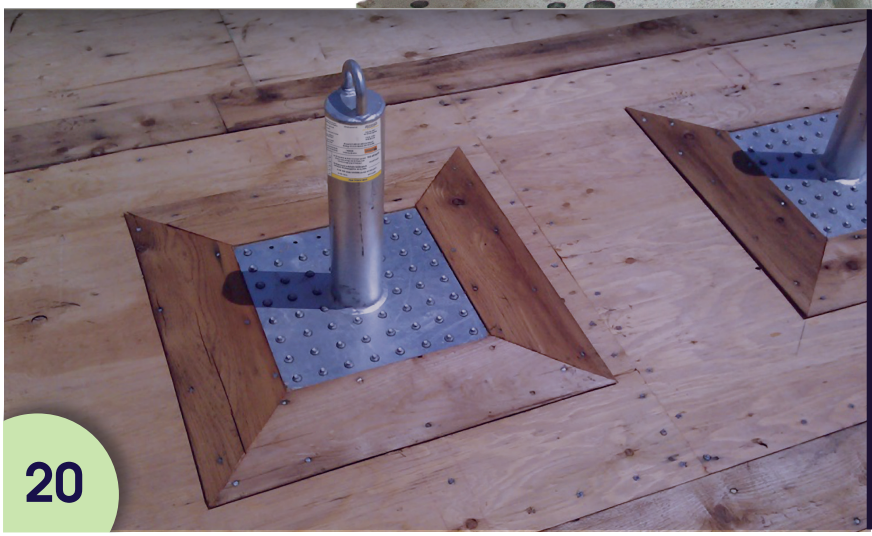
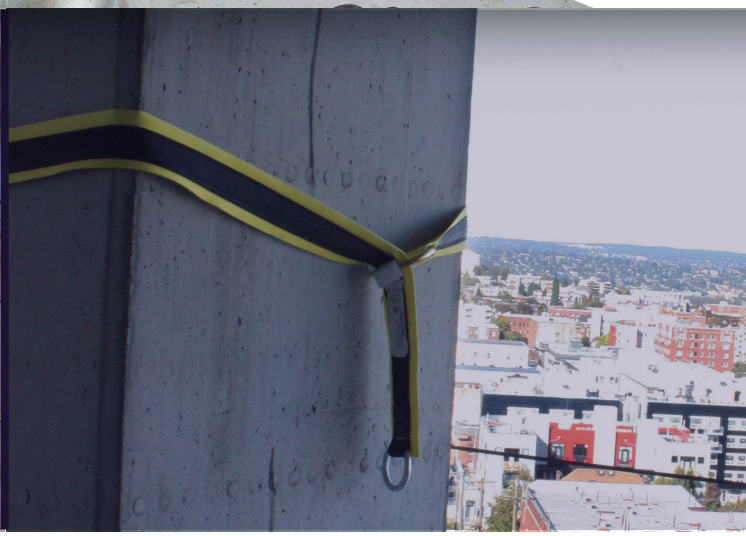
Z359.18-2017

2017 Safety Requirements for Anchorage Connectors for Active Fall Protection Systems

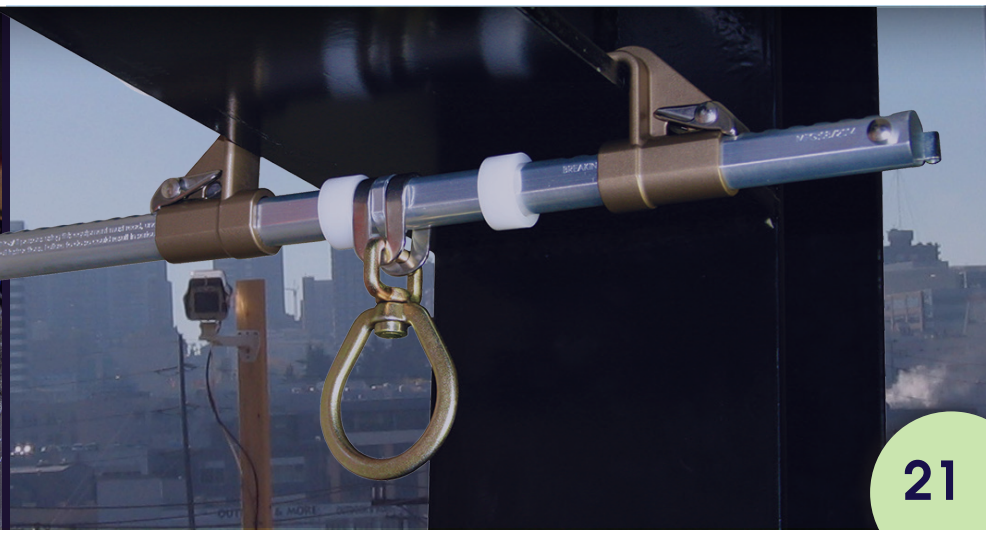
The latest of the ANSI Z359 standards to be released, Z359.18 addresses the design, performance, and testing requirements of anchorage connectors. In stark contrast to Z359.1, which was the last standard to address anchorage connectors, and which combined all anchorage connectors as a single category, Z359.18 creates three new "types" of anchorage connector, and also greatly expands the required tests needed for ANSI compliance.





Anchor Types:

- **Type A:** An anchorage connector (other than a Type D or T anchorage connector) designed for an active fall protection system.
- **Type T:** An anchorage connector designed to support a suspended component/tie-back line or for an active fall protection system.
- **Type D:** An anchorage connector designed to allow deformation or movement when arresting a fall with the purpose of absorbing fall energy and reducing the strength requirements of the anchorage to which it is attached. Deformation may be permanent or temporary. In some cases, these anchorage connectors may not be suitable for work positioning, rescue, rope access, and suspended component/tie-back because of their low serviceability load rating. Also, travel restraint may be acceptable based on the serviceability rating and deformation limits of the individual product.



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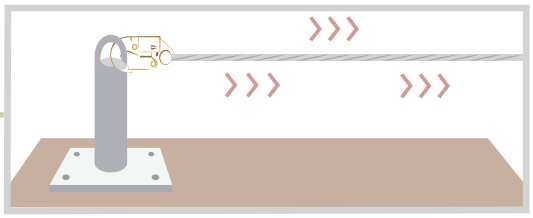
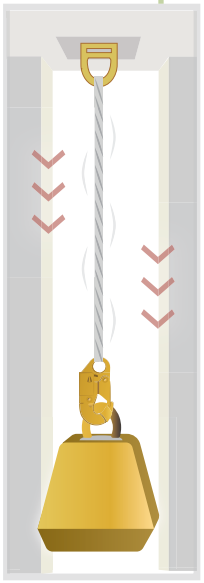
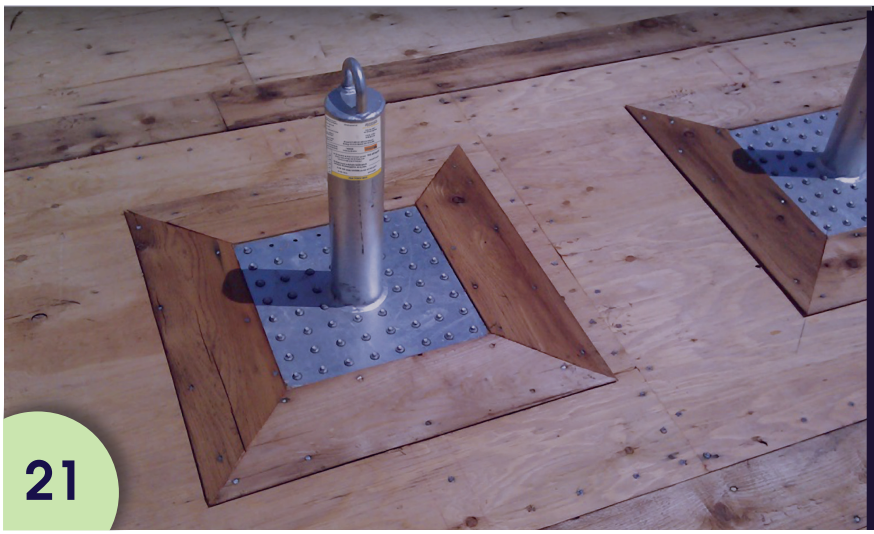
For **static strength testing**, both Type A and Type T anchors must withstand a minimum 5,000 lb. load. Type D anchors must withstand a static load between 2,700 lbs. and 5,000 lbs., and their deformation must be measured so that it may be accounted for in fall clearance calculations.



For **dynamic strength testing**, both Type A and Type T anchors must not allow a 282 lb. test weight to impact the ground when dropped with a 3 ft. free fall, while Type D anchors must do the same but with a 6 ft. free fall.



Residual strength testing is simply a repetition of the initial dynamic test for Type A and Type T anchors. Residual testing for Type D anchors is also a



a repeat of the dynamic strength test, but with a 3 ft. free fall. Serviceability load testing is not required for Type A anchors, however for Type T anchors it is done by applying the greater of twice the working load or 2,500 lbs., applied at up to 900 lbs. per minute and maintained for at least 3 minutes. For Type D anchors, serviceability testing is done by applying the greater of twice the working load or 450 lbs., applied gradually over at least 1 minute and maintained for at least 3 minutes. Finally, **corrosion testing** is also conducted. For Type A and Type D anchors, ferrous components of the anchorage connector cannot show evidence of red rust or other corrosion after two, 24 hour salt spray exposures. For Type T anchors, ferrous components of the anchorage connector cannot show evidence of red rust or other corrosion over more than 5% of their surface area after a 500-hour salt spray exposure.