NATE
THE COMMUNICATIONS INFRASTRUCTURE CONTRACTORS ASSOCIATION

NATE SEMC
SAFETY EQUIPMENT MANUFACTURERS COMMITTEE

2023 NATE SEMC FALL ARREST LANYARD TESTING REPORT



Acknowledgment

The SEMC would like to acknowledge NATE for their dedication to the safety of the men and women who make wireless communication possible. Without their leadership, support, and vision, this fall arrest lanyard testing would not have been possible. We would also like to thank the following organizations and each participant from these organizations for their support:

- 3M
- American Tower Corporation
- Crown Castle
- Deuer Development
- Elk River, Inc.
- FallTech
- GME Supply Co
- Guardian Fall
- Lee Antenna & Line Service, Inc
- MILLERCO
- NATE Climber Connection Film Crew
- Petzl
- Safety LMS
- SBA Communication Corporation
- SKYLOTEC North America LP
- TSC Wireless Telecom Construction
- USA Telecom Insurance Services Inc.
- University of Dayton Research Institute (UDRI)

Introduction

The testing event was performed to provide feedback to NATE members, industry stakeholders and manufacturers. The results of the testing event are meant to raise the bar on safety by increasing awareness and improving testing methods.

All testing was conducted at the University of Dayton Research Institute (UDRI) over the course of two days, with 5 different scenarios and over 100 drop tests completed. The facility was an indoor, climate-controlled environment. The testing utilized new and used equipment attached to an antenna supporting structure designed to the ANSI/TIA-222 standard. The SEMC consulted various stakeholders to determine the 19 most commonly used lanyards in the industry. These lanyards consisted of different force tolerances, construction type/style, and connectors. As most climbers in the industry are only given one set of lanyards for all their work at height activities, the SEMC elected to test all 19 different lanyards in each scenario equally. The information specific to the lanyards tested can be found at the end of this document. The fall arrest lanyards utilized for this testing met the requirements of ANSI/ASSP Z359. The SEMC elected to utilize a 310 lb. test torso to better replicate real world scenarios, including the climber's movement, motion, placement on the system, and center of gravity. Previous results have shown the importance of this type of testing.

Participation was not limited to the SEMC. All relevant industry stakeholders were encouraged to participate. For the manufacturers that chose not to participate, their equipment was purchased from a distributor so that it could be included in the testing. All work at height for the testing and setup was performed by competent climbers, and all equipment was installed and utilized with the input from the participating manufacturers.

The testing protocols outlined in this document were not conducted under American National Standard Institute (ANSI) requirements and therefore should not be construed as ANSI testing. The tests performed were not intended to conform to the current ANSI/ASSP Z359 testing protocol or manufacturer's instructions, but rather to emulate real world scenarios encountered in the telecommunications industry and common misuse applications. The results, notes and photos within this paper will show the possible outcomes from misuse of fall arrest lanyards.

Explanation of Fall Factor

A Fall Factor (FF) is defined as the ratio between the length of free fall and the length of the lanyard that is being utilized to absorb the dynamic force of a fall. To calculate a Fall Factor, you must divide the length of the free fall by the length of the lanyard. The measurement of the length is determined from where a climber falls to the point where the climbers fall arrest lanyard starts to arrest the impact forces. As an example, the climber is using a fall arrest lanyard that measures 6 feet in length and falls freely 6 feet before the lanyard is engaged, that is a FF1. The equation is 6 feet of free fall divided by 6-foot lanyard length (6/6=1). If the climber had been anchored at the floor level and had a potential of 12 feet of free fall, it would result in a FF2 (12/6=2). If the Fall Factor is higher, it means there is a greater impact on the body, which could result in serious injury or even death. Fall Factors and lanyard types may be identified by other terms that identify whether they are a 6 foot or 12 foot free fall lanyard.

Test 1

Fall Factor 1 Drop Test

Purpose

The purpose is to complete dynamic performance testing to evaluate the impact force generated by a fall arrest lanyard undergoing a Fall Factor 1. The drop scenario was designed to replicate a single climber falling while anchoring the fall arrest lanyard at the height of the dorsal d-ring.

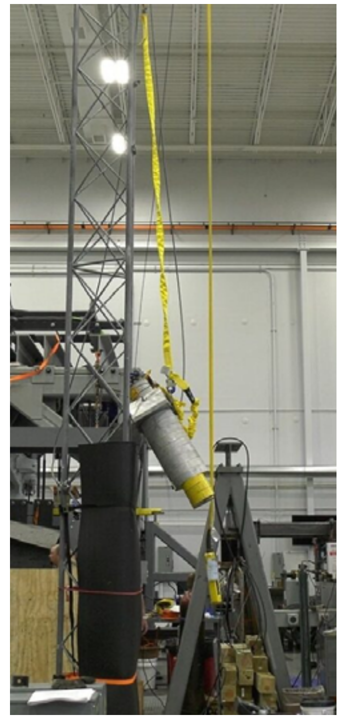
Test Setup

The fall arrest lanyard was connected to the integral dorsal d-ring of the 310 lb. test torso and anchored to a load cell that was connected directly to the tower structure. The dorsal d-ring and the load cell connection point were at the same height, therefore creating a Fall Factor 1 with 6 ft of free fall. The maximum impact force at the anchor and total fall distance was measured. The lanyard was inspected pre and post drop for any damage or deficiencies.

Notes

When anchoring fall arrest at or below a Fall Factor 1, the user shall ensure that the lanyard is specifically designed for that fall distance. In some cases, a Fall Factor 2 lanyard may exceed the ANSI Maximum Arresting Force (MAF) if utilized in a Fall Factor 1 event.

Setup



Post Drop

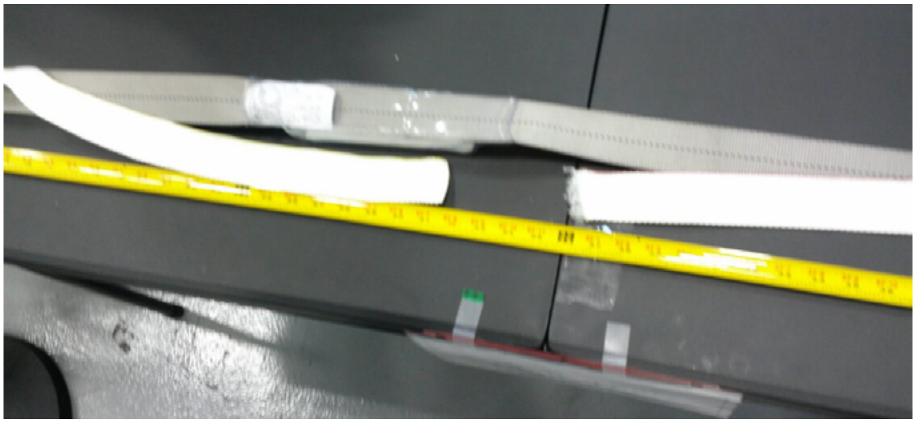
L14

Post Drop

Test 1 Results

LANYARD #	Fall Factor	Deployment Distance (inches)	Post Drop Load (lbf)	Caught by Lanyard (L) or Back-up(B)	HARDWARE																SOFT MATERIALS								
						TORSO CONNECTOR - GATE			TORSO CONNECTOR - BODY			ANCHOR CONNECTOR - GATE			ANCHOR CONNECTOR - BODY			OTHER NON-CONNECTING DEVICE				SHEATH			SHOCK ABSORBER				
					FUNCTIONS - NO DAMAGE	Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken	FUNCTIONS - NO DAMAGE	Rips/Tears/Cuts	Abrasion	Broken Stitching	Rips/Tears/Cuts	Abrasion	Broken Stitching	Full Deployment	Partial Deployment
L1	1	43 1/4	440 *	L	•																•							X	
L2	1	43	640	L	•																•							X	
L3	2	33 3/8	540	L				X													•								X
L4	1	51 1/4	1900	L	•																•							X	
L5	1	42 1/4	590	L	•																•							X	
L6	1	43 3/8	900	L	•																•							X	
L7	2	19 7/8	600	L	•																•								X
L8	1	41 1/4	880	L	•																•							X	
L9	1	42 3/4	1020	L	•																•							X	
L10	1	45 1/4	430	L	•																•							X	
L11	1	44 3/4	1020	L	•																•							X	
L12	1	43 1/2	1020	L	•																•							X	
L13	1	44	520	L	•																•								
L14	1	43 1/2	1640	L	•																•							X	
L15	1&2	38 1/4	1100	L	•																•								X
L16	1&2	37 1/4	1120	L	•																•								X
L17	1&2	43 1/8	500	L	•																•								X
L18	1&2	43 1/2	1200	L	•																•								X
L19	1&2	42 1/4	530	L	•																•								X

L4


L4

Test 2

Fall Factor 2 Drop Test

Purpose

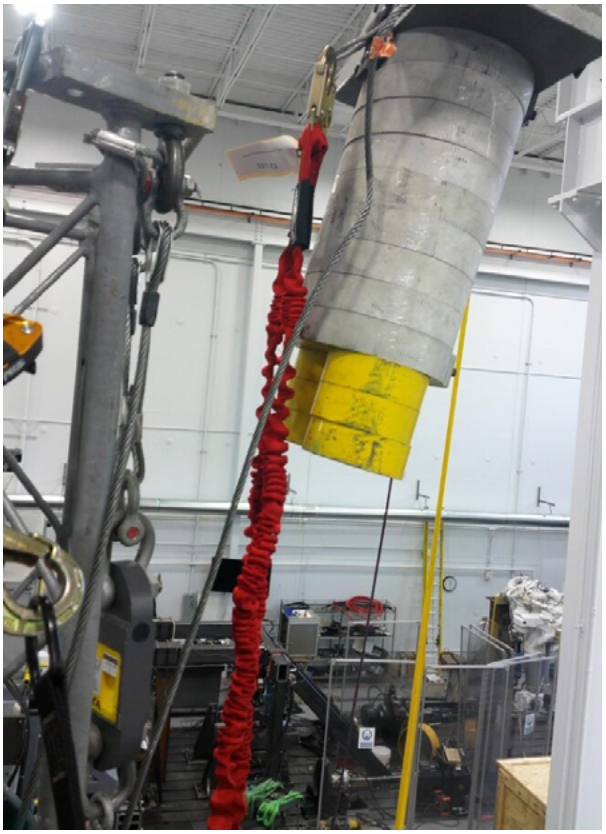
The purpose is to complete dynamic performance testing to evaluate the impact force generated by a fall arrest lanyard undergoing a Fall Factor 2. The drop scenario was designed to replicate a single climber falling while their fall arrest lanyard is anchored at or near the walking working surface. As an example: attaching while working on top of a monopole.

Test Setup

The fall arrest lanyard was connected to the integral dorsal d-ring of the 310 lb. test torso and anchored to a load cell that was connected directly to the tower structure. The test torso was raised to height above the anchor point of 4 ft, therefore creating a Fall Factor close to 2 with 10 ft of free fall. The maximum impact force at the anchor and total fall distance was measured. The lanyard was inspected pre and post drop for any damage or deficiencies.

Notes

When anchoring fall arrest at or above a Fall Factor 1, the user shall ensure that the lanyard is specifically designed for that fall distance. A Fall Factor 1 only lanyard shall never be anchored in a way that may impose a greater fall distance than a Fall Factor 1.



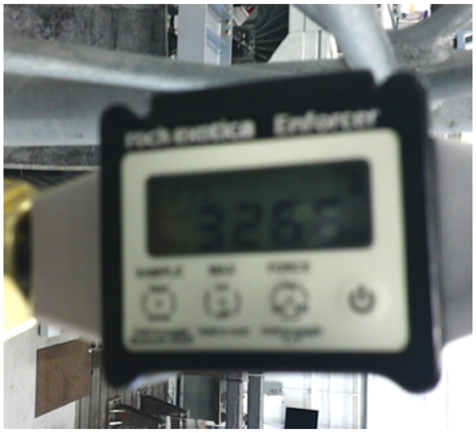
Setup

Setup

Post Drop

Test 2 Results

LANYARD #	Fall Factor	Deployment Distance (inches)	Post Drop Load (lbf)	Caught by Lanyard (L) or Back-up(B)	HARDWARE																SOFT MATERIALS								
						TORSO CONNECTOR - GATE			TORSO CONNECTOR - BODY			ANCHOR CONNECTOR - GATE			ANCHOR CONNECTOR - BODY			OTHER NON-CONNECTING DEVICE				SHEATH			SHOCK ABSORBER				
					FUNCTIONS - NO DAMAGE	Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken	FUNCTIONS - NO DAMAGE	Rips/Tears/Cuts	Abrasion	Broken Stitching	Rips/Tears/Cuts	Abrasion	Broken Stitching	Full Deployment	Partial Deployment
L1	1	48 1/8	3356	L	•																•							X	
L2	1	47 7/8	3388	L	•																•							X	
L3	2	60 3/8	1224	L	•																•								X
L4	1	58 1/2	2960	L	•																•							X	
L5	1	47 1/8	3224	L	•																•							X	
L6	1	48	3266	L	•																•							X	
L7	2	32 3/8	1770	L	•																•								X
L8	1	46 3/4	3050	L	•																•							X	
L9	1	53 1/4	2920	L	•																•							X	
L10	1	52 1/2	2962	L	•																•							X	
L11	1	51 1/2	2768	L	•																•							X	
L12	1	48 3/4	3098	L	•																•							X	
L13	1	47 5/8	3098	L	•																•							X	
L14	1	46 1/4	3100	L	•																•							X	
L15	1&2	57	1528	L	•																•							X	
L16	1&2	55	1554	L	•																•							X	
L17	1&2	62	1310	L	•																•								X
L18	1&2	63	1238	L	•																•								X
L19	1&2	61	1326	L	•																•								X



L6

L7

L18

Test 3

Leading Edge Over Horizontal Member with Non-Leading Edge Lanyards Drop Test

Purpose

The purpose was to complete dynamic performance testing to evaluate the integrity of the fall arrest lanyard over a horizontal member during a fall event. The drop scenario was to replicate a single climber falling from the face of the mount, while their fall arrest lanyard was anchored back to the structure.

Setup

Test Setup

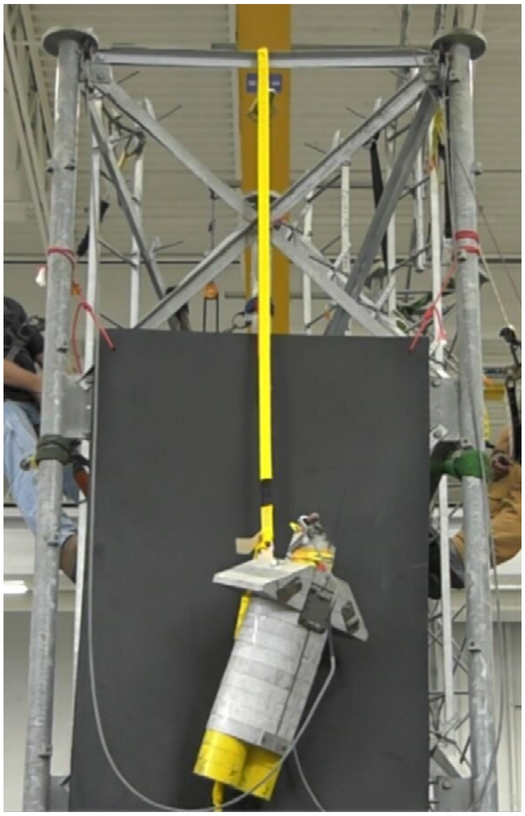
The fall arrest lanyard was connected to the integral dorsal d-ring of the 310 lb. test torso and anchored directly to the tower structure with the use of a wire rope sling. The wire rope was anchored on the leg of a three-leg self-supporting structure with the lanyard routed across the interior of the structure and over a horizontal cross member of the opposing face. The test torso was raised 4ft above the anchor point, therefore creating a Fall Factor close to 2 with 10 ft of free fall. When released, the torso traveled down the face opposing the anchor leg, therefore ensuring the lanyard received a 90-degree break-over at the horizontal cross member. The total fall distance was measured. The lanyard was inspected pre and post drop for any damage or deficiencies.

Notes

When anchoring fall arrest at or above a Fall Factor 1, the user shall ensure that the lanyard is specifically designed for the anticipated fall distance. The user must consider the path of the potential fall and protect the lanyard from abrasion. A Fall Factor 1 ONLY lanyard shall never be anchored in a way that may impose a greater fall distance than a Fall Factor 1. Lanyards that are designed for leading edge work should be considered for use when there is potential for abrasion during a fall event.

Also noted was the significant damage to the horizontal cross member (bending) due to the impact of the fall arrest lanyard during the fall event.

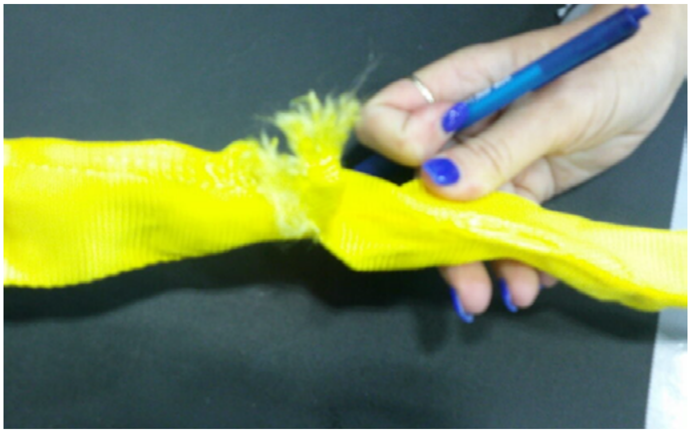
Setup



Post Drop

Test 3 Results

				HARDWARE																SOFT MATERIALS								
					TORSO CONNECTOR - GATE			TORSO CONNECTOR - BODY			ANCHOR CONNECTOR - GATE			ANCHOR CONNECTOR - BODY			OTHER NON-CONNECTING DEVICE				SHEATH			SHOCK ABSORBER				
LANYARD #	**Fall Factor**	**Deployment Distance (inches)**	**Caught by Lanyard (L) or Back-up(B)**	FUNCTIONS - NO DAMAGE	Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken	FUNCTIONS - NO DAMAGE	Rips/Tears/Cuts	Abrasion	Broken Stitching	Rips/Tears/Cuts	Abrasion	Broken Stitching	Full Deployment	Partial Deployment
L1	1	27 1/8	L	•																					X			X
L2	1	49 3/8	L	•																					X		X	
L3	2	59 5/8	L	•																					X			X
L4	1	50 1/8	L	•																•							X	
L5	1	46 1/4	L	•																•							X	
L6	1	26 1/2	L	•																					X			X
L7	2	15 1/4	L	•																•								X
L8	1	32 3/4	L	•																					X			X
L9	1	49 1/4	L	•																		X					X	
L10	1	36 1/8	L	•																					X			X
L11	1	32	L	•																		X						X
L12	1	35 1/2	L	•																					X			X
L13	1	34 1/2	L	•																					X			X
L14	1	34 1/2	L	•																					X			X
L15	1&2	26	L	•																•								X
L16	1&2	25	L	•																•								X
L17	1&2	34	L	•																•								X
L18	1&2	39	L	•																•								X
L19	1&2	34	L	•																•								X



L1

Test 4

Lanyard Tie-back Drop Test

Purpose

The purpose was to complete dynamic performance testing to evaluate the integrity of the fall arrest lanyard used in a tie-back configuration at the anchor during a fall event. The drop scenario was to replicate a situation where the fall arrest lanyard connector was not compatible with the anchorage due to gate opening and the climber elects to connect the lanyard back to itself around the anchor.

Test Setup

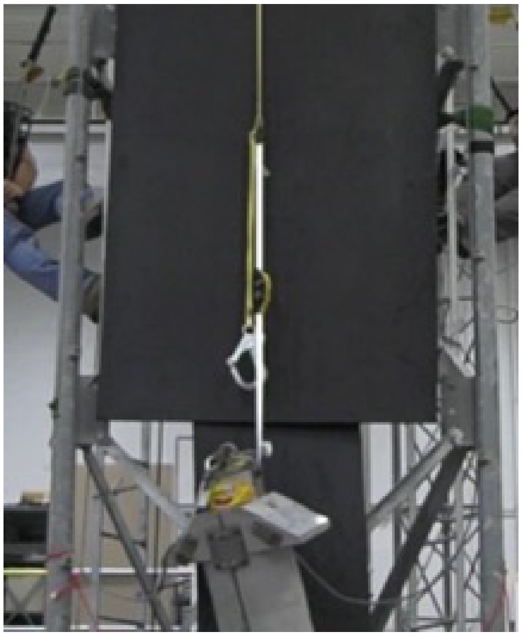
The fall arrest lanyard was connected to the integral dorsal d-ring of the 310 lb. test torso and anchored to a 2"x2" angle iron cross member of the structure tied back to itself or in a "choked" configuration. Lanyards that were designed for tie-back were anchored as instructed by the manufacturer. Lanyards that were not designed to be tied back were anchored by means of looping the lanyard webbing around the cross member and attaching the connector back to the webbing leg of the lanyard creating a "choked" connection. The test torso was raised to 4 ft above the anchor point, therefore creating a fall factor close to 2 with 10 ft of free fall. The total fall distance was measured. The lanyard was inspected pre and post drop for any damage or deficiencies.

Notes

Never tie back or "choke" a lanyard back to itself unless it is designed to be used in that configuration. When anchoring fall arrest at or above a Fall Factor 1, the user shall ensure that the lanyard is specifically designed for that fall distance. A Fall Factor 1 ONLY lanyard shall never be anchored in a way that may impose a greater fall distance than a Fall Factor 1.

Setup

Setup



Post Drop

L4*

Test 4 Results

LANYARD #	Fall Factor	Deployment Distance (inches)	Caught by Lanyard (L) or Back-up(B)	HARDWARE																SOFT MATERIALS								
				FUNCTIONS - NO DAMAGE	TORSO CONNECTOR - GATE			TORSO CONNECTOR - BODY			ANCHOR CONNECTOR - GATE			ANCHOR CONNECTOR - BODY			OTHER NON-CONNECTING DEVICE			FUNCTIONS - NO DAMAGE	SHEATH			SHOCK ABSORBER				
					Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken		Rips/Tears/Cuts	Abrasion	Broken Stitching	Rips/Tears/Cuts	Abrasion	Broken Stitching	Full Deployment	Partial Deployment
L1	1	46 1/2	L	•																•		X					X	
L2	1	47 3/4	L	•																•		X					X	
L3	2	46 1/4	L	•																•		X						X
L4	1	53 1/2	*	•																•		X					X	
L5	1	27 3/4	L	•																	X							X
L6	1	43 1/8	L	•																•		X					X	
L7	2	21 3/4	L	•																•								X
L8	1	45 1/8	L	•																		X					X	
L9	1	49 1/2	L	•																		X					X	
L10	1	48 3/4	L												X						X						X	
L11	1	42 3/8	L	•																		X					X	
L12	1	49 1/4	L	•																		X					X	
L13	1	43 3/8	L	•																•							X	
L14	1	43 3/8	L	•																•							X	
L15	1&2	44 3/8	L	•																•							X	
L16	1&2	41 3/8	L	•																•								X
L17	1&2	49 3/8	L	•																•		X						X
L18	1&2	49 3/8	L	•																•		X						X
L19	1&2	49 3/8	L	•																•		X						X

L5

L10

Test 5

Drop on Diagonal Connection Drop Test

Setup

Post Drop

Purpose

The purpose was to complete dynamic performance testing to evaluate the integrity of the fall arrest lanyard connecting device sliding down the diagonal member during a fall event. The drop scenario was designed to replicate a situation where the climber is transitioning across the face of the structure while connecting fall arrest lanyard to a diagonal cross member during a fall event.

Test Setup

The fall arrest lanyard was connected to the integral dorsal d-ring of the 310 lb. test torso and anchored directly to the tower structure on a 45-degree, 2"x2" angle iron cross member. The connector of the lanyard was positioned up the 45-degree cross member, and then raised 2 ft away from the structure leg. The test torso was raised to 4 ft above the anchor point, therefore creating a near fall factor 2 with 10 ft of free fall. When the test torso was released to fall, the lanyard connector slid down the cross member 2 ft until contacting the structure leg applying gate loading to the lanyard connector. The total fall distance was measured. The lanyard was inspected pre and post drop for any damage or deficiencies.

Notes

When attaching a lanyard to the structure, the user must ensure the lanyard connector does not have unintended travel at the anchor, a compatible anchor strap designed for the application may be used to prevent slide or travel. When anchoring fall arrest at or above a Fall Factor 1, the user shall ensure that the lanyard is specifically designed for that fall distance. A Fall Factor 1 ONLY lanyard shall never be anchored in a way that may impose a greater fall distance than a Fall Factor 1.

L9

L18

Test 5 Results

LANYARD #	Fall Factor	Deployment Distance (inches)	Caught by Lanyard (L) or Back-up(B)	HARDWARE																SOFT MATERIALS								
					TORSO CONNECTOR - GATE			TORSO CONNECTOR - BODY			ANCHOR CONNECTOR - GATE			ANCHOR CONNECTOR - BODY			OTHER NON-CONNECTING DEVICE				SHEATH			SHOCK ABSORBER				
				FUNCTIONS - NO DAMAGE	Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken	Cracked	Bent	Broken	FUNCTIONS - NO DAMAGE	Rips/Tears/Cuts	Abrasion	Broken Stitching	Rips/Tears/Cuts	Abrasion	Broken Stitching	Full Deployment	Partial Deployment
L1	1	47 1/2	L												X					•							X	
L2	1	47 3/8	L												X					•							X	
L3	2	55 3/8	L	•																•								X
L4	1	57 1/4	L												X					•							X	
L5	1	46 3/8	L												X					•							X	
L6	1	44 7/8	L												X					•							X	
L7	2	28 7/8	L												X					•								X
L8	1	46 3/4	L												X					•							X	
L9	1	47 5/8	L												X					•							X	
L10	1	51 3/8	L												X					•							X	
L11	1	49	L												X					•							X	
L12	1	48	L												X					•							X	
L13	1	45	L												X					•							X	
L14	1	43 5/8	L												X					•							X	
L15	1&2	49 1/4	L	•																•								X
L16	1&2	45 1/2	L	•																•								X
L17	1&2	54 1/4	L	•																•								X
L18	1&2	53	L	•																•								X
L19	1&2	54 5/8	L	•																•								X

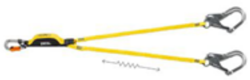
L14

L2

L6

Item	Identifier	Item Description	Twin or Y-Style	Fall Factor	Tie Back	Steel or Aluminum	Snap Hook or Carabiner	Image
1244409	**L1**	3M DBI/Sala	Twin	1	NO	Aluminum	Snap	
1244448	**L2**	3M DBI/Sala	Twin	1	NO	Steel	Snap	
1246032	**L3**	3M DBI/Sala	Y-Style	2	NO	Aluminum	Snap	
1342125	**L4**	3M Protecta	Y-Style	1	NO	Steel	Snap	
8240Y3	**L5**	FallTech	Twin	1	NO	Steel	Snap	
8240Y3A	**L6**	FallTech	Twin	1	NO	Aluminum	Snap	
8247Y3	**L7**	FallTech	Twin	2	NO	Steel	Snap	
8260732D	**L8**	FallTech	Y-Style	1	YES	Steel	Snap	
35386	**L9**	Elk River	Twin	1	NO	Steel	Snap	
35478	**L10**	Elk River	Twin	1	NO	Steel	Snap	

CONTINUED ON NEXT PAGE

Item	Identifier	Item Description	Twin or Y-Style	Fall Factor	Tie Back	Steel or Aluminum	Snap Hook or Carabiner	Image
35488	**L11**	Elk River	Twin	1	NO	Aluminum	Snap	
35416	**L12**	Elk River	Twin	1	NO	Aluminum	Carabiner	
11203	**L13**	Guardian	Twin	1	NO	Steel	Snap	
21215	**L14**	Guardian	Twin	1	NO	Aluminum	Snap	
L014BA01	**L15**	Petzl	Y-Style	1&2	NO	Aluminum	Snap	
L015BA00	**L16**	Petzl	Y-Style	1&2	YES	Steel	Snap	
L-0558-1.8	**L17**	Skylotec	Y-Style	1&2	NO	Aluminum	Snap	
L-0562-1,8	**L18**	Skylotec	Y-Style	1&2	NO	Steel	Snap	
L-0533-1,8	**L19**	Skylotec	Y-Style	1&2	NO	Aluminum	Carabiner	

NATE
THE COMMUNICATIONS INFRASTRUCTURE CONTRACTORS ASSOCIATION

NATE SEMC
SAFETY EQUIPMENT MANUFACTURERS COMMITTEE

Key Take-Aways from Testing

1. Consult manufacturer's instructions for the use, inspection, and maintenance of your personal fall arrest system (PFAS) along with your company policy. Test results confirm that not following manufacturer's instructions may result in malfunction or equipment failure.
2. When anchoring fall arrest at or below a fall factor 1, the user shall ensure that the lanyard is specifically designed for that fall distance. In some cases, a fall factor 2 lanyard may exceed the ANSI Maximum Arresting Force (MAF) if utilized in a fall factor 1 fall event.
3. When anchoring fall arrest at or above a fall factor 1, the user shall ensure that the lanyard is specifically designed for that fall distance. A fall factor 1 only lanyard shall never be anchored in a way that may impose a greater fall distance than a fall factor 1.
4. The user must consider the path of the potential fall and protect the lanyard from abrasion. Lanyards that are designed for leading edge work should be considered for use when there is potential for abrasion during a fall event.
5. Never "choke" a lanyard back to itself unless designed to be tied back in that configuration.
6. When attaching a lanyard to the structure, the user must ensure the lanyard connector does not have unintended travel at the anchor, Anchor Straps may be used to prevent slide or travel.
7. Lanyards must be inspected per the manufacture's requirements prior to use. Dirt, moisture, Ultraviolet Light, and prior wear/use may all affect the performance of the lanyard.

For additional information and previous testing reports, please reference the following documents by visiting bit.ly/NATE_SEMC_Docs.

NATE Safety Sleeve Testing Final Report

2020 Guide for Wire Rope Safety Climbs on Antenna Supporting Structures

2021 NATE SEMC Wire Rope Safety Sleeve Testing Report II

2022 Guide For Powered Ascender Use on Antenna Supporting Structures