Performance Evaluation of Select Fall Arrest Equipment to 420 lb Capacity

Background

Equipment Selection

Evaluation Criteria

Results & Conclusions

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Capital Safety

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Fall Protection Experts

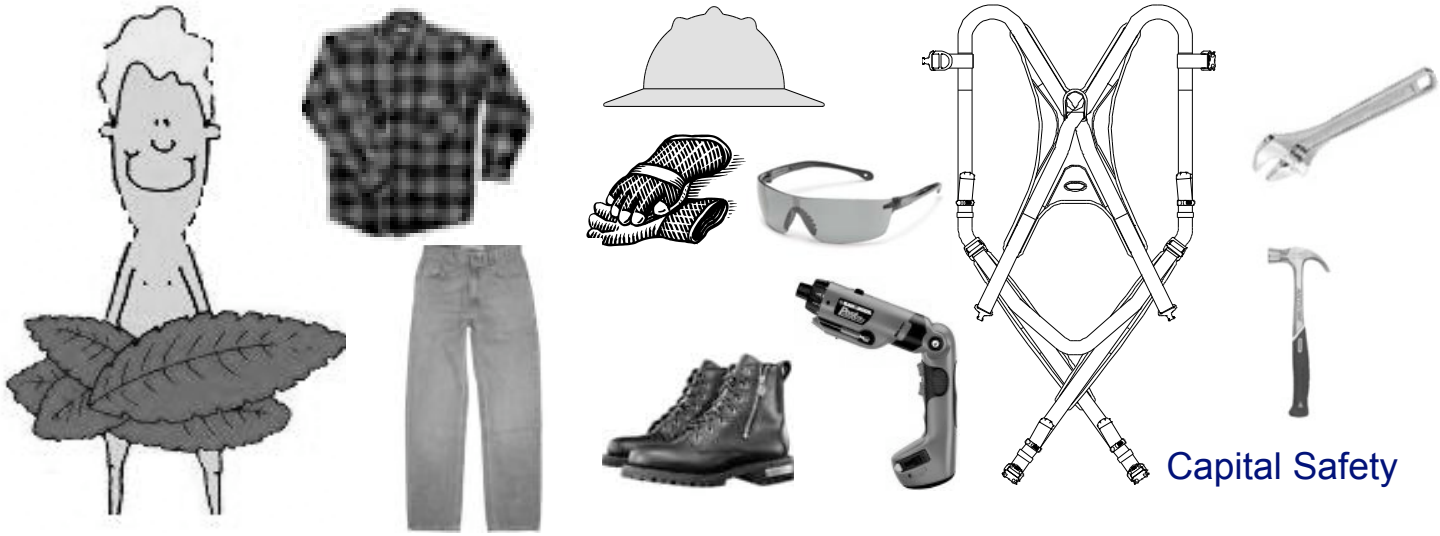
What is Capacity?

ANSI Z359.1:

- The combined weight for which the component is designed to be used. Combined weight includes the user's body weight and clothing, tools, and any other objects carried or borne by the user.

OSHA:

- Capacity is not defined however, test protocols provided apply to "combined person and tool weight"



Why is capacity important?

Key to defining equipment limitations:

- Capacity influences the design and testing of each system component
- System performance can be compromised if the capacity limit is exceeded: MAF, fall clearance, FOS
- Research indicates that deceleration rates for heavier people may be too great for lighter people. Equipment capacity rating provides guidelines for proper selection
- Standards developers are considering “classifying” equipment according to total energy limits i.e. free fall x capacity

Why 420 lbs (191Kg)?

There is a need:

- Historically test criteria found in fall protection regulations and standards are based around a capacity limit of 310 lbs (141kg) – Result is that most equipment designed to this level only

- Safety directors: “We know we have workers that are greater than 310 pounds and we want them to have the right equipment”

- Looking at the fully equipped worker:

Clothing + PPE	≥ 15 lbs (7 kg)
Tools and other	≥ 50 lbs (23 kg)
Body weight	≥ 245 lbs (111 kg)
Total	**≥ 310 lbs (Our target 420 lbs)**

Equipment Selection

System components:

- Body support component
  - Full Body Harness (FBH), three base types
- Connecting subsystems
  - Energy Absorber + Lanyard (EA+L), one type
  - Self Retracting Lanyard (SRL), two types
  - Fall Arrestor + Lanyard + Lifeline (FACSS), one type
  - Work positioning lanyard (WPL), two types
- Ladder safety subsystem (LSS), one type
- Connectors (CON), as required by system

Full Body Harness

Twelve models representative of series:

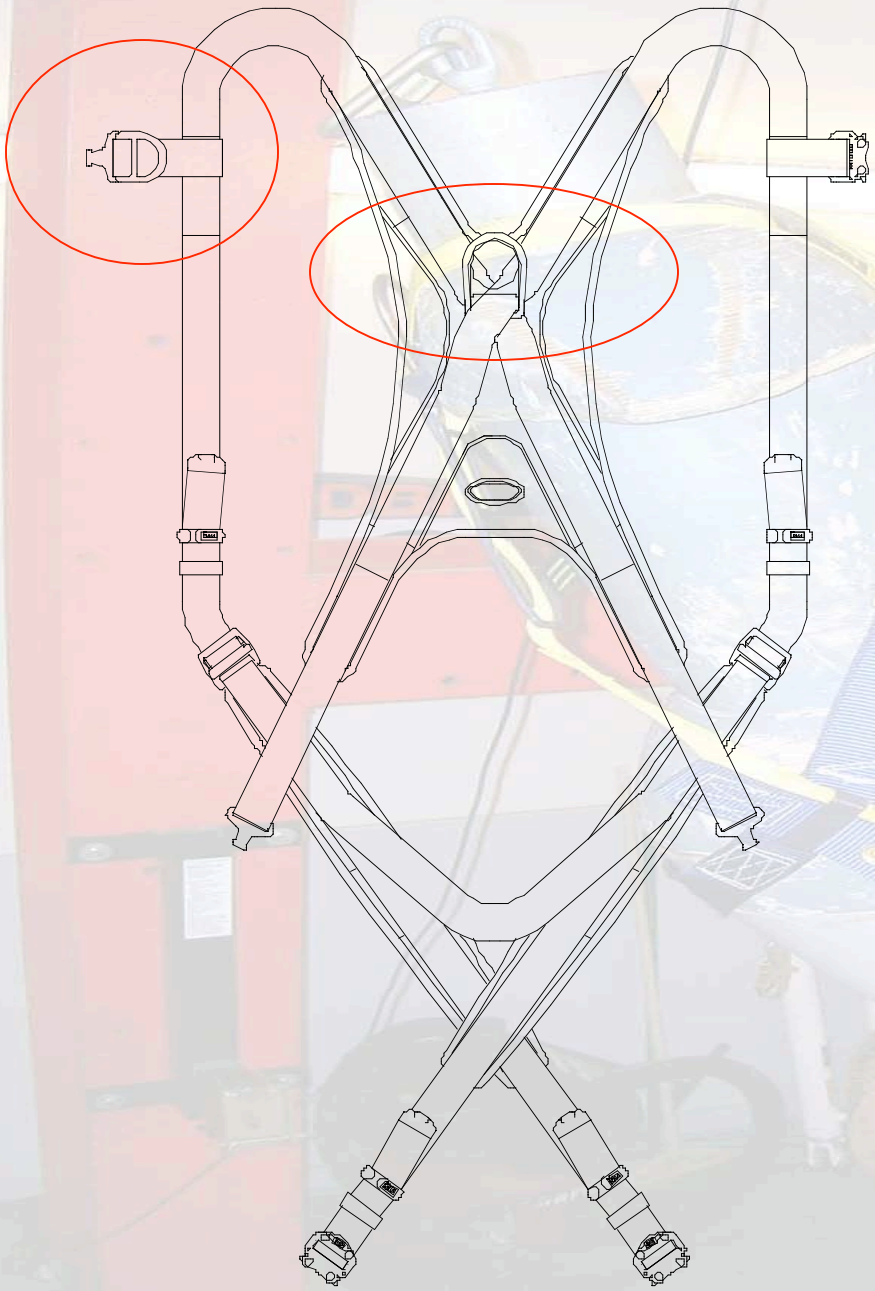
AE / Type	Fall Arrest (dorsal)	Work Positioning (hip level)	Ladder Climbing (front)	Work Seat (pair)
Vest	X	X	X	X
X-Over	**X**	**X**	**X**	
Step-in	X	X	X	

Adjuster Buckles

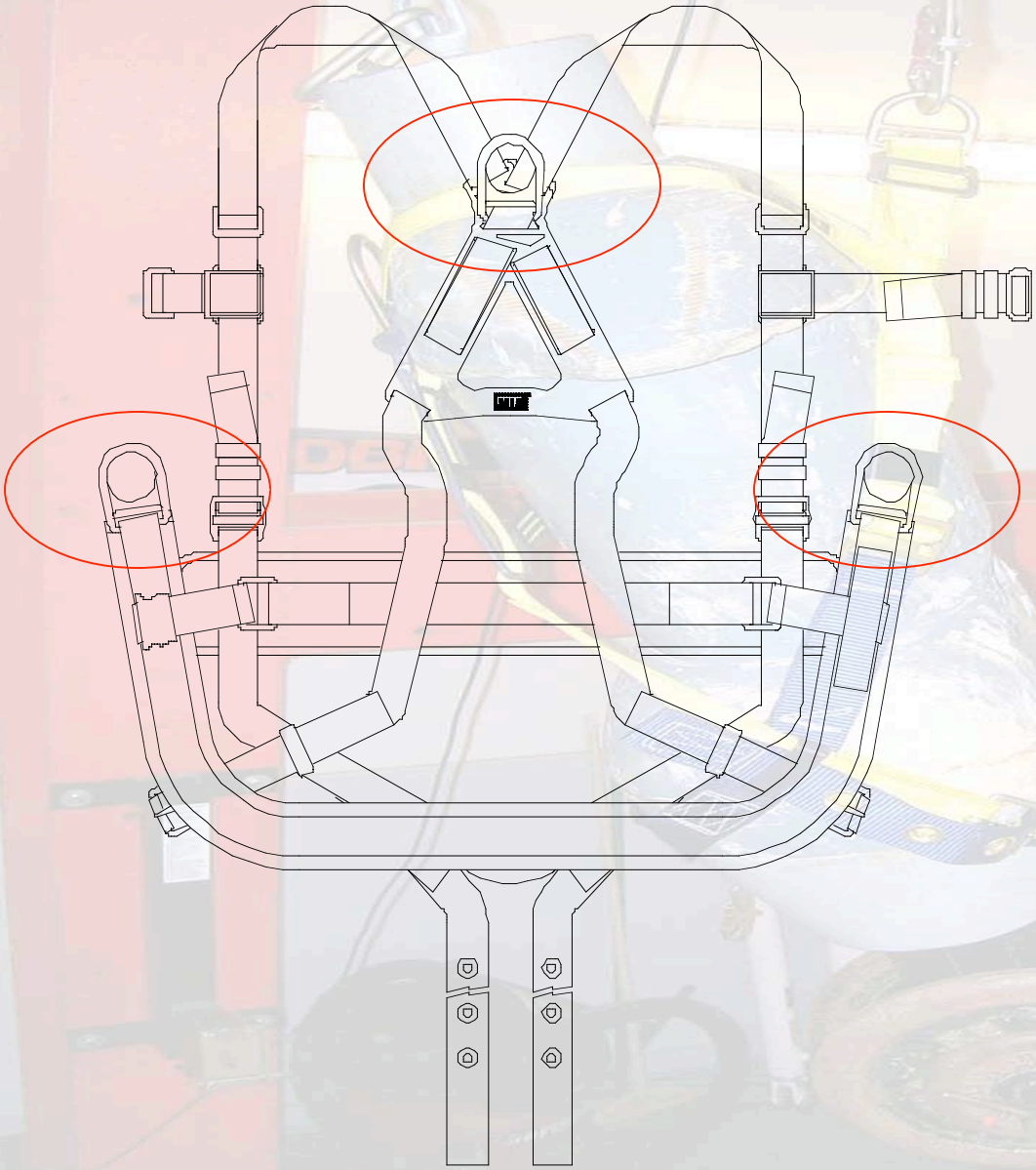
Tongue Buckle

Pass-Through

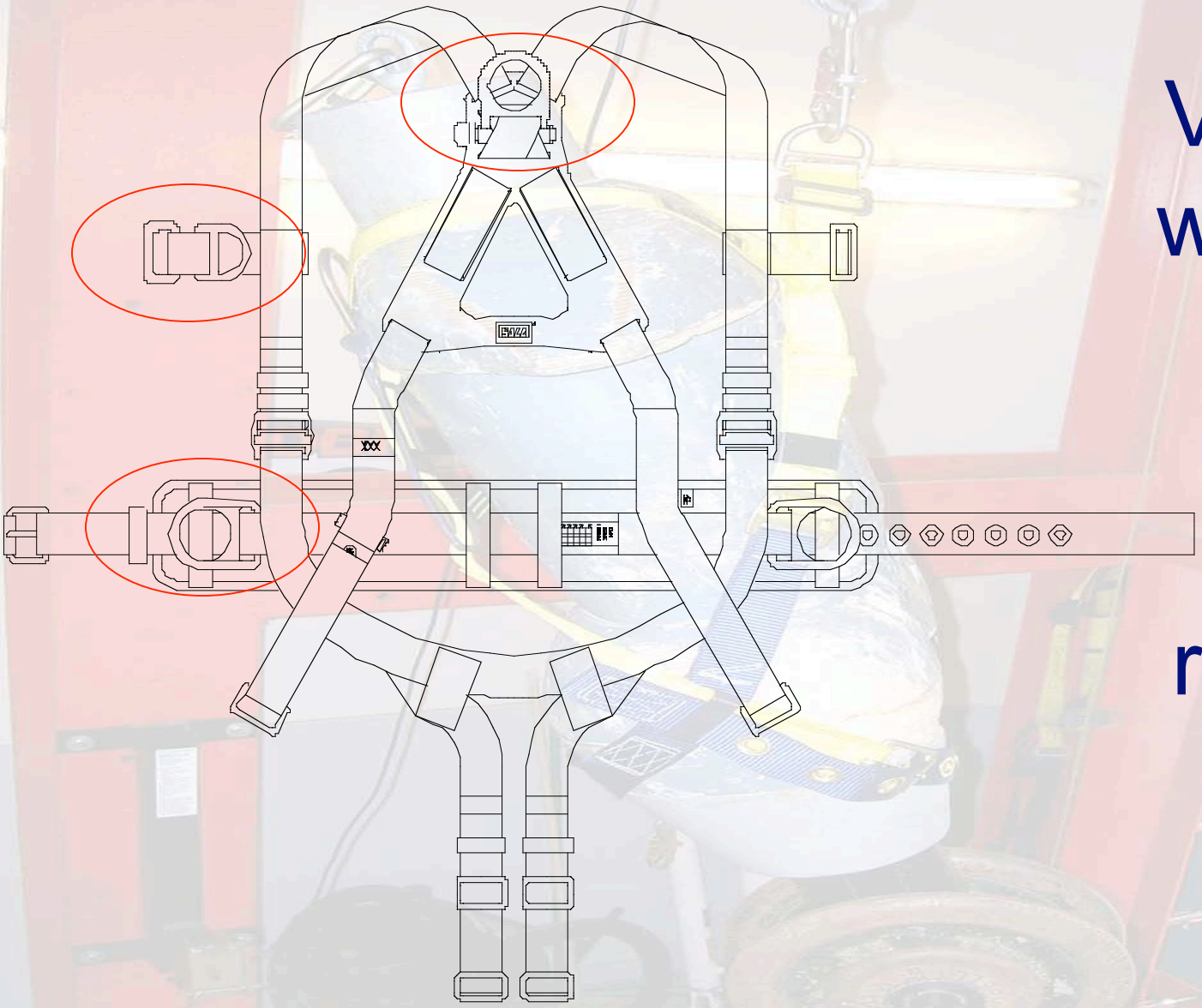
Quick Connect



Vest type with front and dorsal D-rings, QC buckles

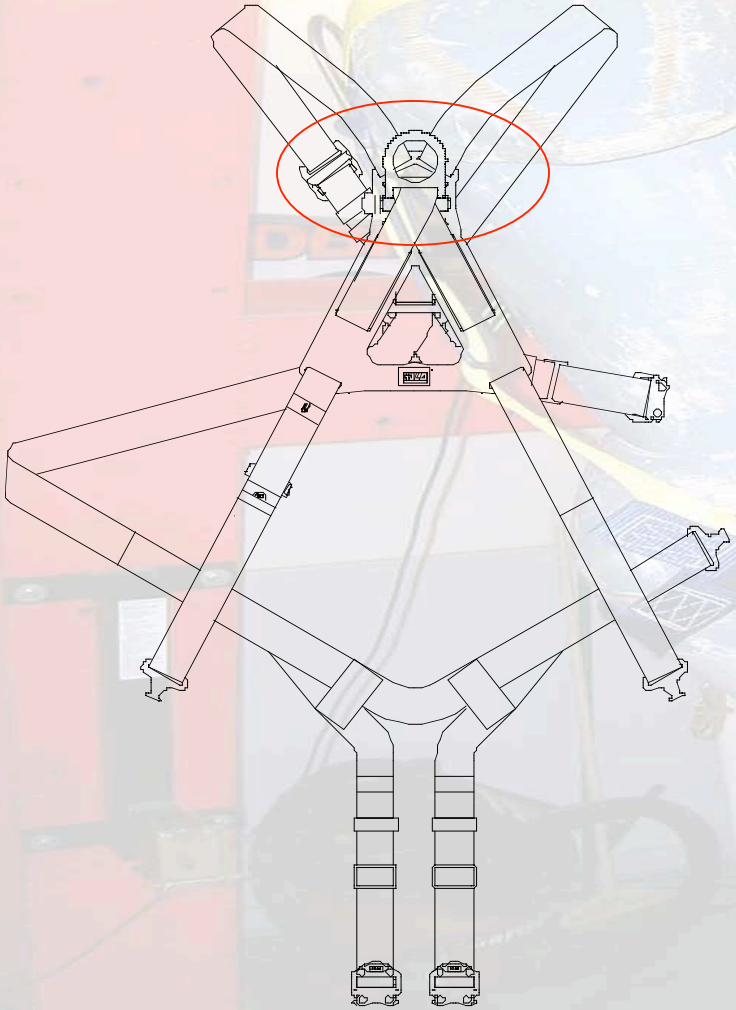


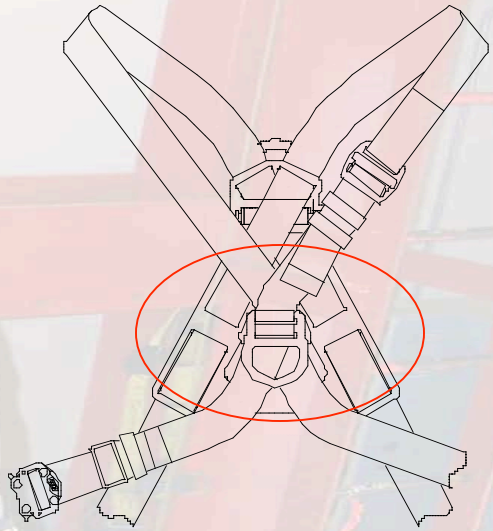
Vest type with work seat and dorsal D-rings, TB buckles

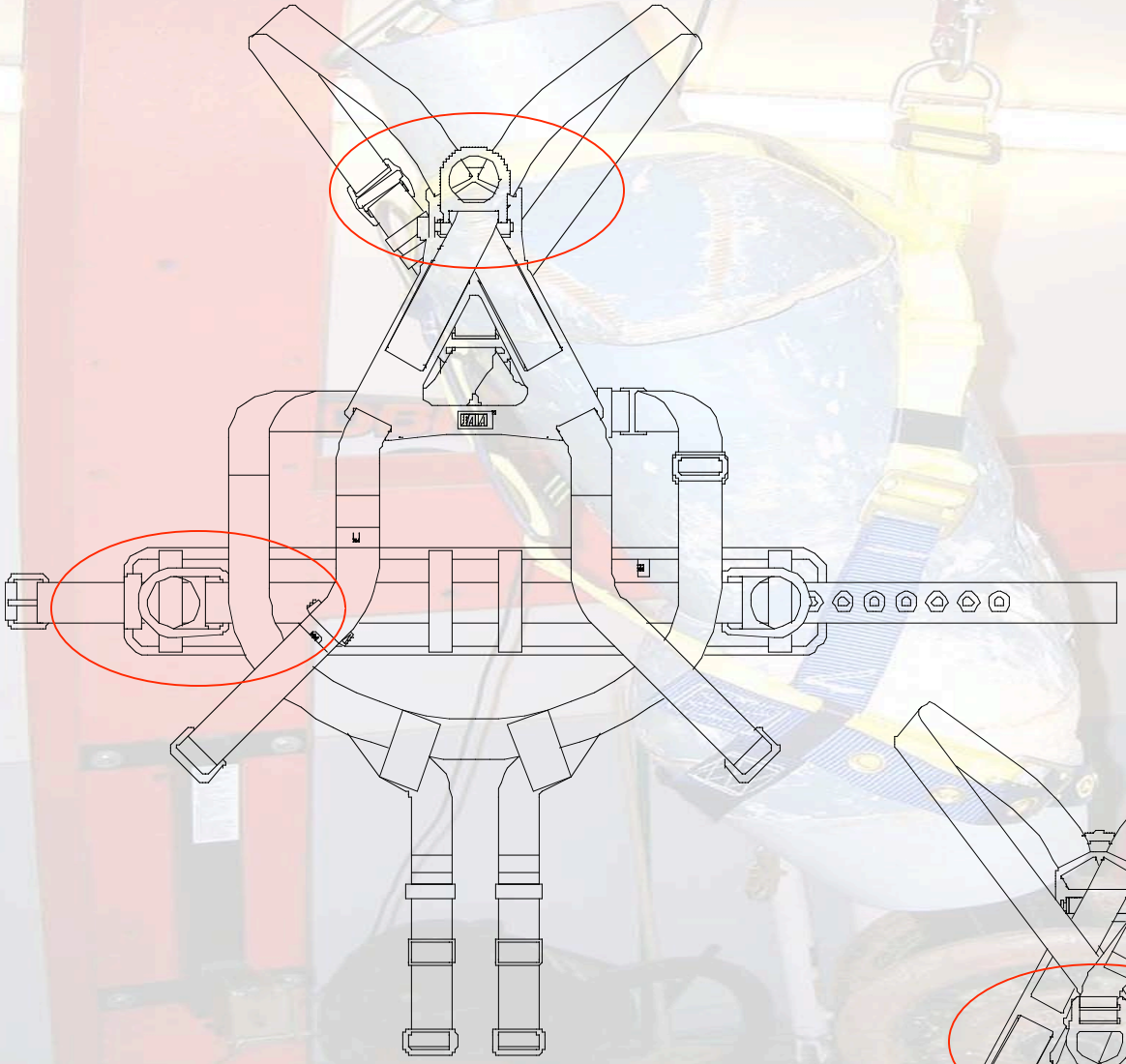


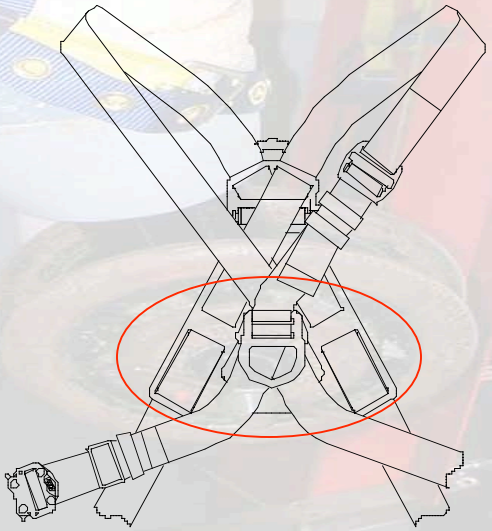
Vest type with front, dorsal, and hip level D-rings, PT buckles

X-over type with front and dorsal D-ring, QC buckles

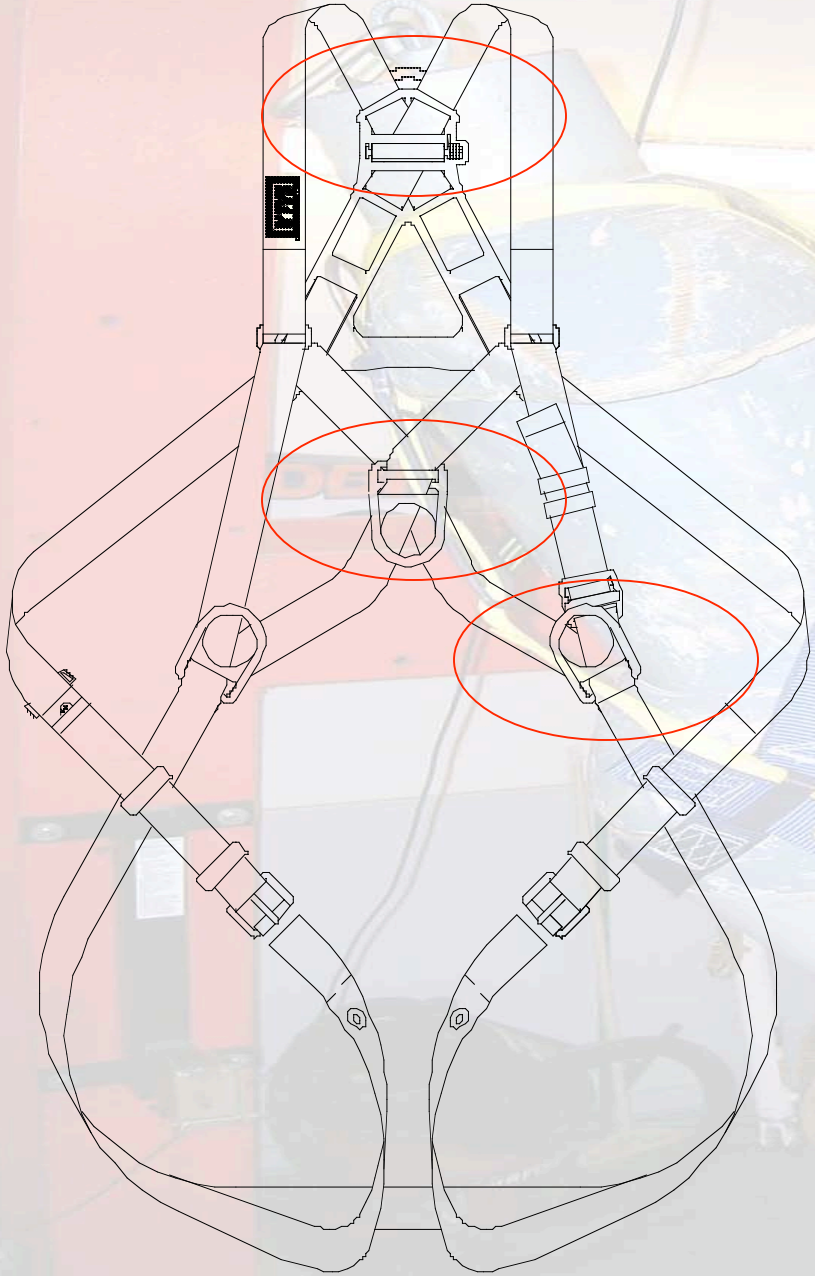






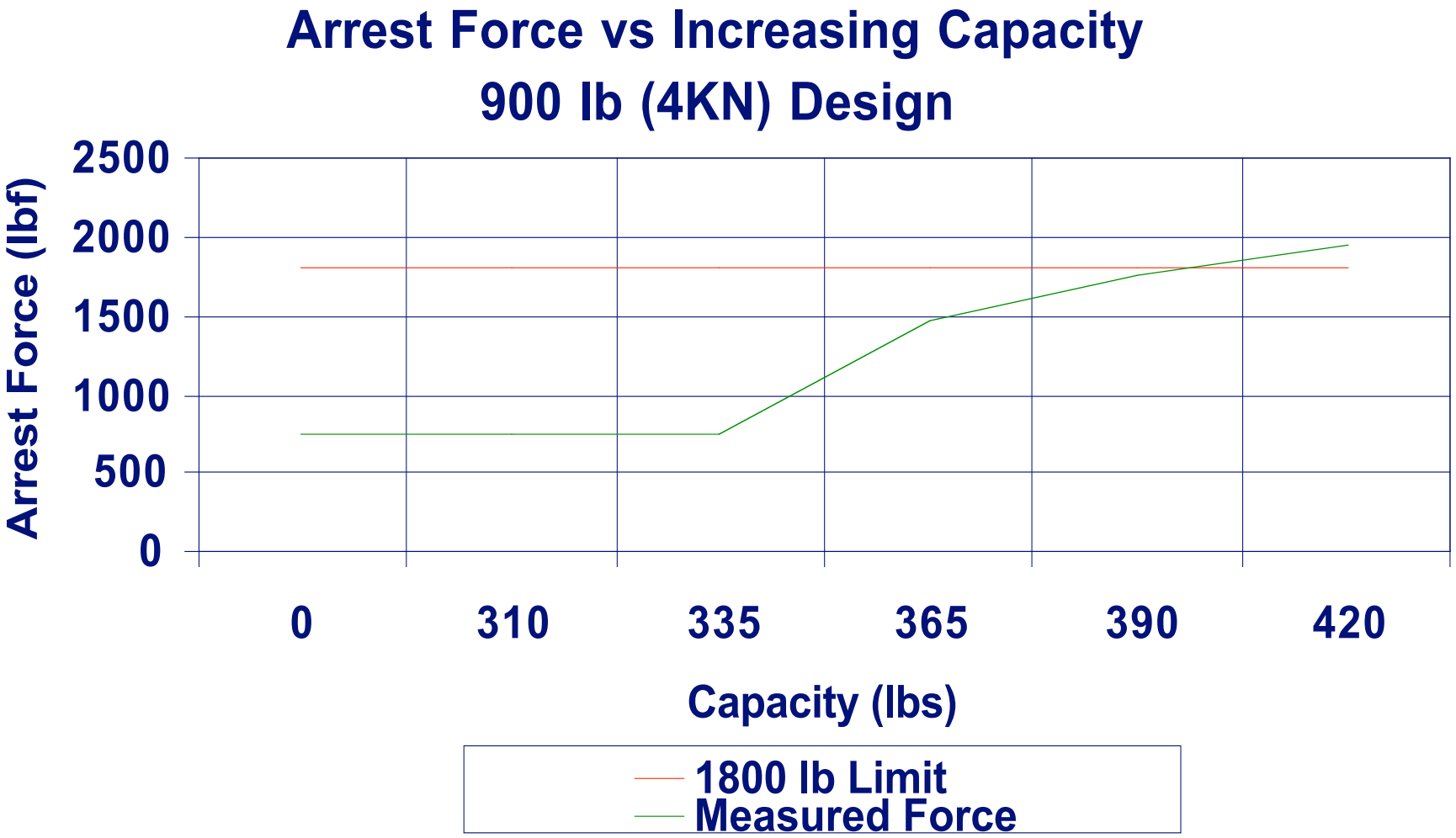


X-over type with front, dorsal, and hip level D-rings, PT buckles



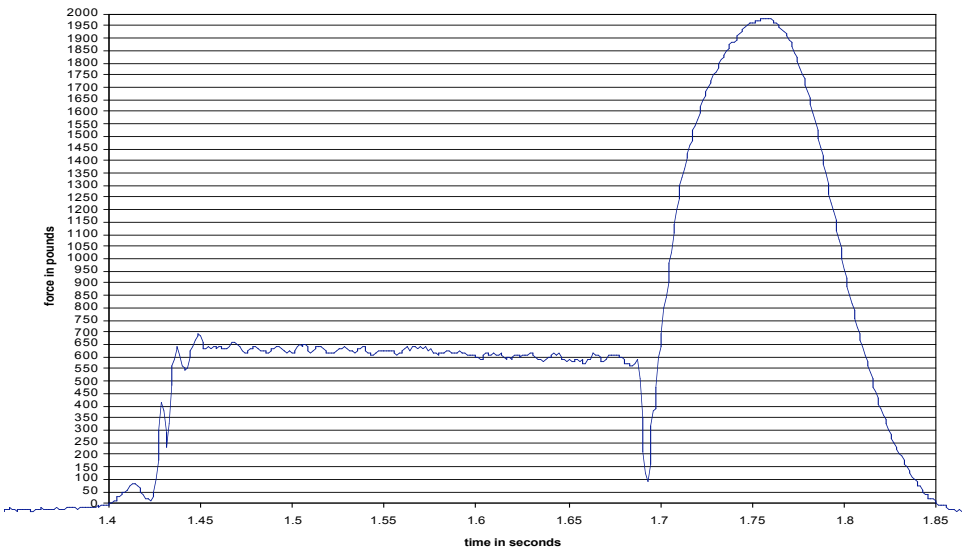
Step-in type with front, dorsal, and hip level D-rings, TB buckles

Energy Absorber + Lanyard

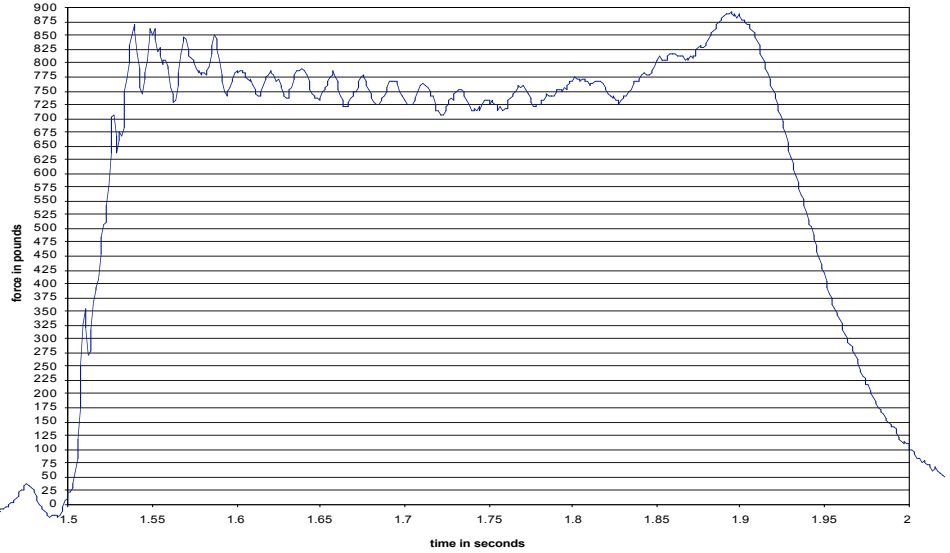


Energy Absorber + Lanyard

- Type selected: Tear-ply high capacity energy absorber, “CE type” designed to maintain MAF to 6 kN (1350 lb) or less.

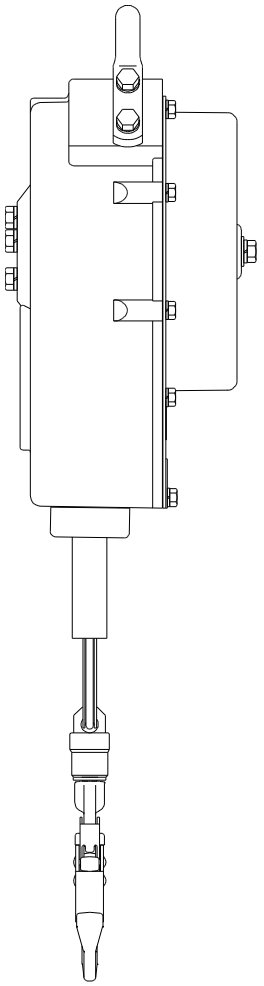


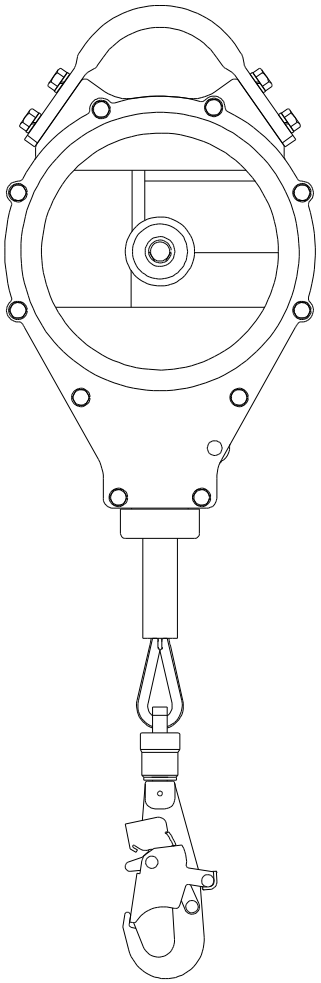
Standard 900 lb (4kN)



High capacity 1350 lb (6kN)

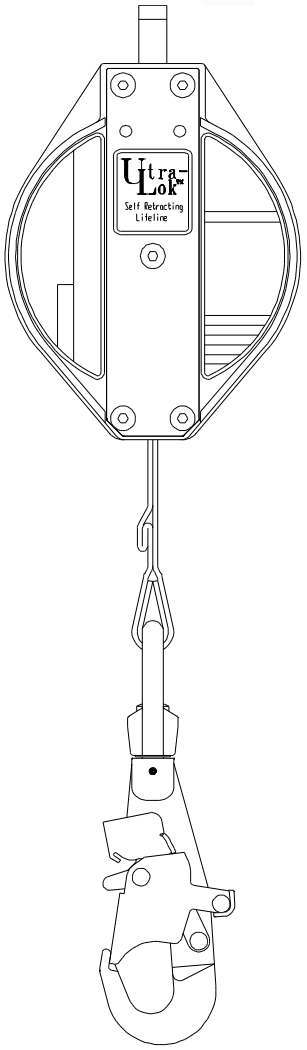
SRL





Two "internal brake" SRL models selected:

- 50 ft (15m) length wire rope lanyard portion
- 11 ft (3.3m) length synthetic webbing lanyard portion



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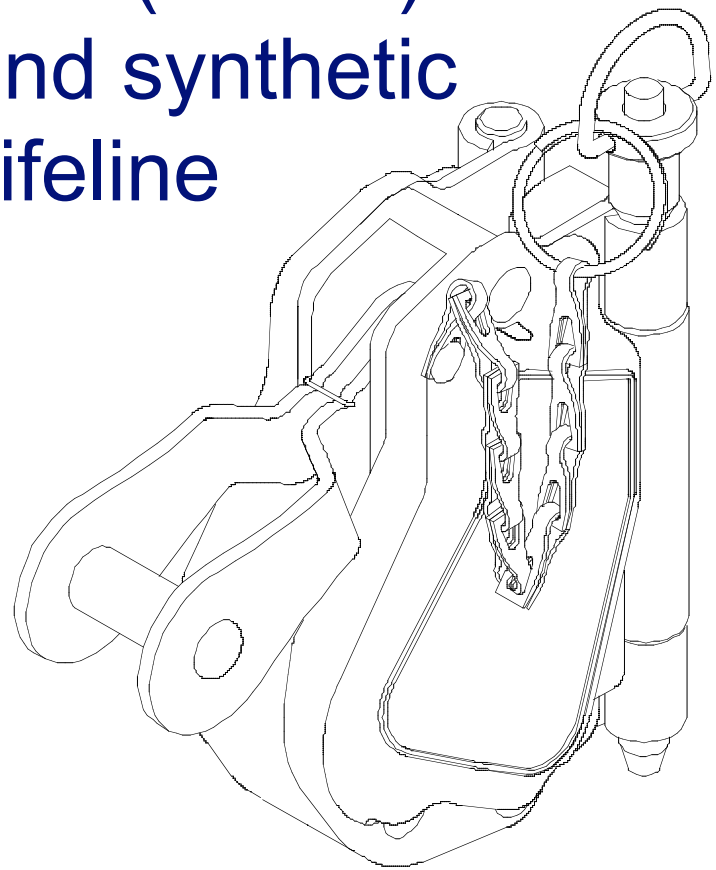
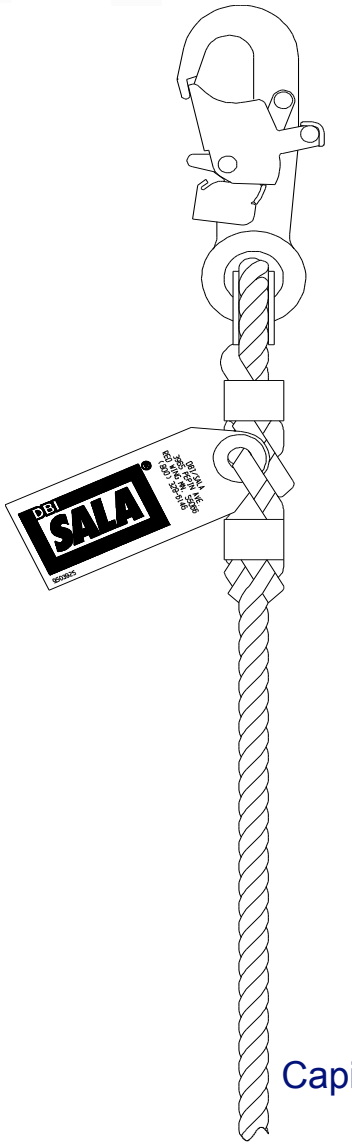
Fall Arrester and Lifeline

- Mobile fall arrestor with 5/8” (16mm) 3-strand synthetic rope lifeline





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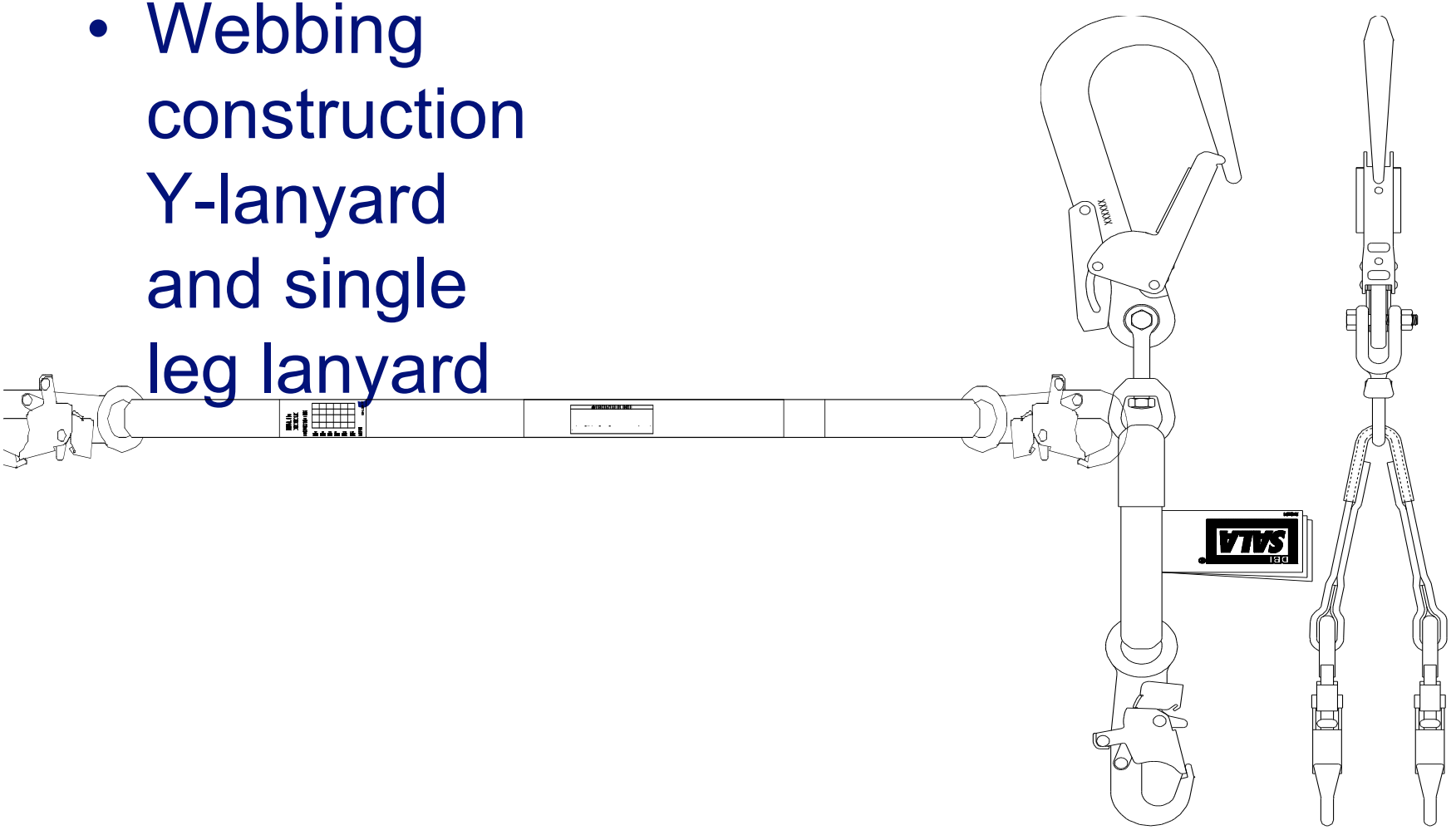
Work Positioning Lanyards

- Webbing construction Y-lanyard and single leg lanyard



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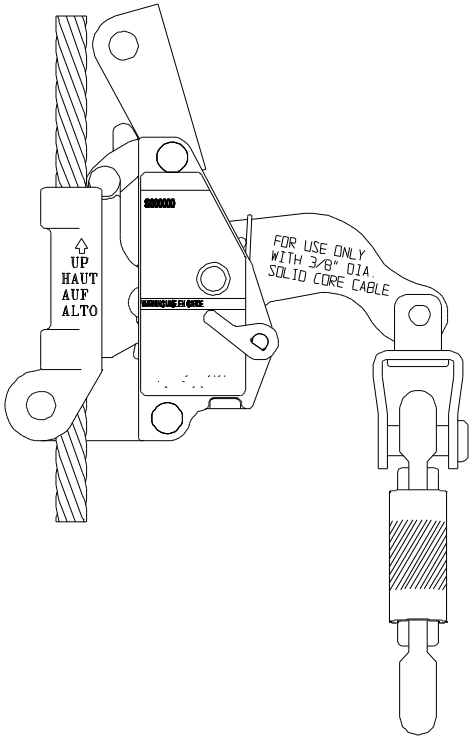
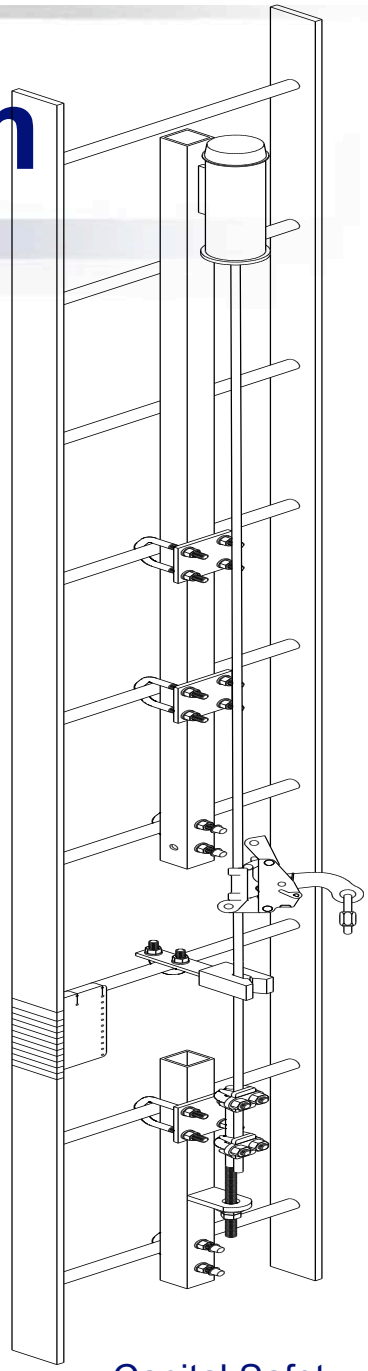
Ladder Safety Subsystem

- Fixed ladder cable based system with traveling sleeve





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Evaluation Criteria

Fall arrest:

- Dynamic performance criteria (OSHA system)
  - A maximum arresting force of 1800 lbs (8 kN)
  - A maximum deceleration distance of 3.5 ft (1.1m)
  - Maximum free fall 6 ft (1.8m)
- Test method
  - Apply OSHA Subpart M “Force Test” methods modified by proportionally increasing test weight:

220 lb test weight = Increase test weight = 300 lb (136 kg)

310 lb Capacity 420 lb Capacity

Evaluation Criteria

Fall arrest (continued):

- Dynamic strength criteria (OSHA system)
  - Must not release test weight/torso
- Test method
  - Apply OSHA Subpart M “strength test” methods modified by proportionally increasing test weight: 300lb (136kg) to 420 lbs (191 kg)
  - Test as system: 4 ft (1.2m) or 7.5 ft (2.3m) free fall
- Static strength
  - Components must meet OSHA minimums

Evaluation Criteria

Work positioning:

- Dynamic strength criteria(OSHA system)
  - Must not release test torso, no MAF limit
- Test method
  - Apply OSHA Subpart M “positioning device system” methods modified by proportionally increasing test weight:

    250 lb test weight = Increase test weight = 340 lb (155 kg)

    310 lb Capacity 420 lb Capacity
- Test using “stiff” work positioning lanyard and 4ft (1.2m) free fall connected to single or D-ring pair
- Static strength criteria
  - Must comply with OSHA Subpart minimums

Evaluation Criteria

Ladder climbing:

- Dynamic performance criteria (system)
  - Must arrest within 6 inches (152mm), no MAF limit
- Test method
  - Test method from ANSI A14.3 standard on fixed ladders proportionally increase test weight: Test weight of 220 lb (100kg) increased to 300 lb (136 kg)
- Dynamic strength
  - No change from ANSI A14.3, 500 lb (227kg) x 1.5 ft (free fall
- Dynamic strength criteria (harness component)
  - Must not release test torso
- Test method
  - Test method from ANSI A14.3 standard on Fixed ladders proportionally increased test weight: Test weight of 220 lb (100kg) increased to 300 lb (136 kg)
  - Free fall 1.3 ft (.4m) with wire rope lanyard

Results

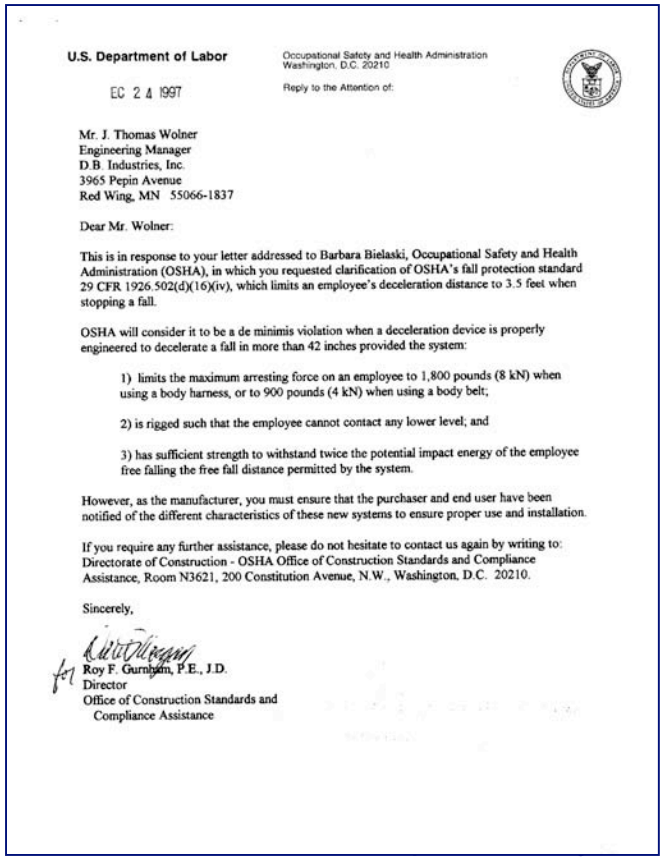
FBH+L+EA System:

FBH Type	FBH Description	Con. Point	EA+ Lanyard	Wt (lbs)	FF (ft)	MAF (lbf)	AD (in)	P/F
Vest	TB/PT/QC Buckles	Dorsal	Wire rope +EA	420	7.5	N/A	N/A	P
X-over	QC Buckles	Dorsal	Wire rope +EA	420	7.5	N/A	N/A	P
Step-in	TB Buckles	Dorsal	Wire rope +EA	420	7.5	N/A	N/A	P
X-over	PT Buckles	Dorsal	Wire rope +EA	300	6.0	860 to 1146	42 to 46	*P

Conclusions

FBH+EA+L System:

- Sufficient strength to withstand twice the potential impact energy of fall permitted by system - No damage to system
- MAF < 1800 lbs
- DD > than 42” limit?
  - OSHA Subpart M clarification:
    - De minimis violation provided,
    - MAF < 1800 LBS (FBH)
    - Worker cannot contact lower level
    - Sufficient strength to withstand twice the potential impact energy.
- Special EA markings
  - Maximum DD = 65 inch (1.6 m)
  - MAF = 1350 lbf (6 kN)
  - Capacity: 130 lbs to 420 lbs



U.S. Department of Labor

Occupational Safety and Health Administration
Washington, D.C. 20210

DEC 24 1997

Reply to the Attention of:

Mr. J. Thomas Wolner
Engineering Manager
D.B. Industries, Inc.
3965 Pepin Avenue
Red Wing, MN 55066-1837

Dear Mr. Wolner:

This is in response to your letter addressed to Barbara Bielaski, Occupational Safety and Health Administration (OSHA), in which you requested clarification of OSHA's fall protection standard 29 CFR 1926.502(d)(16)(iv), which limits an employee's deceleration distance to 3.5 feet when stopping a fall.

OSHA will consider it to be a de minimis violation when a deceleration device is properly engineered to decelerate a fall in more than 42 inches provided the system:

1) limits the maximum arresting force on an employee to 1,800 pounds (8 kN) when using a body harness, or to 900 pounds (4 kN) when using a body belt;

2) is rigged such that the employee cannot contact any lower level; and

3) has sufficient strength to withstand twice the potential impact energy of the employee free falling the free fall distance permitted by the system.

However, as the manufacturer, you must ensure that the purchaser and end user have been notified of the different characteristics of these new systems to ensure proper use and installation.

If you require any further assistance, please do not hesitate to contact us again by writing to: Directorate of Construction - OSHA Office of Construction Standards and Compliance Assistance, Room N3621, 200 Constitution Avenue, N.W., Washington, D.C. 20210.

Sincerely,

for Roy F. Gurnham, P.E., J.D.
Director
Office of Construction Standards and
Compliance Assistance

Results

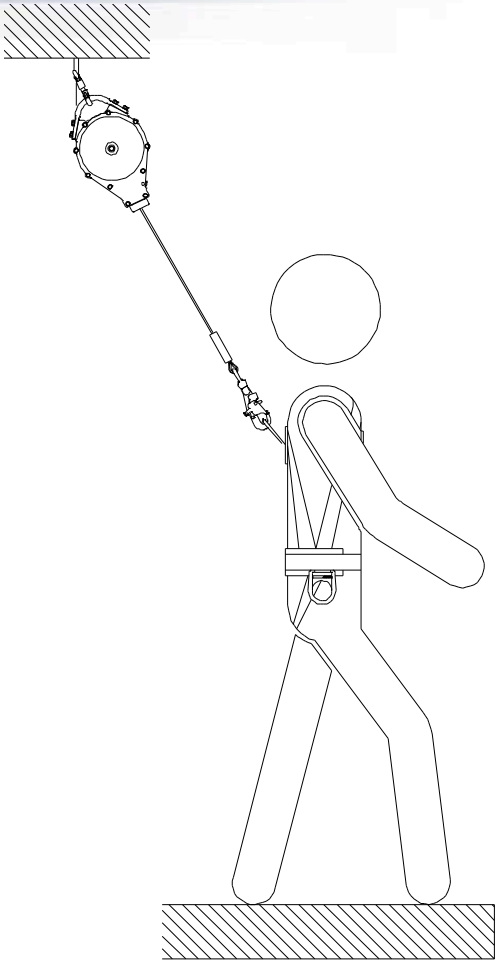
FBH+SRL System:

FBH Type	FBH Description	Con. Point	SRL Type	Wt (lbs)	FF (ft)	MAF (lbf)	AD (in)	P/F
Vest	PT Buckles	Dorsal	Wire rope 50 ft	420	4.0	N/A	N/A	P
Vest	PT Buckles	Dorsal	Wire rope 50 ft	300	“0”	915 to 1180	15 to 34	P
Vest	PT Buckles	Dorsal	Webbing 11 ft	420	4.0	N/A	N/A	P
Vest	PT Buckles	Dorsal	Webbing 11 ft	300	“0”	744 to 925	21 to 33	P

Conclusions

FBH + SRL SYSTEM:

- No damage to system
- Sufficient strength to withstand twice the potential impact energy of fall permitted by system.
- MAF <1800 lbs
- DD < 42 inches
- Special markings: Capacity: 420 lbs



Results

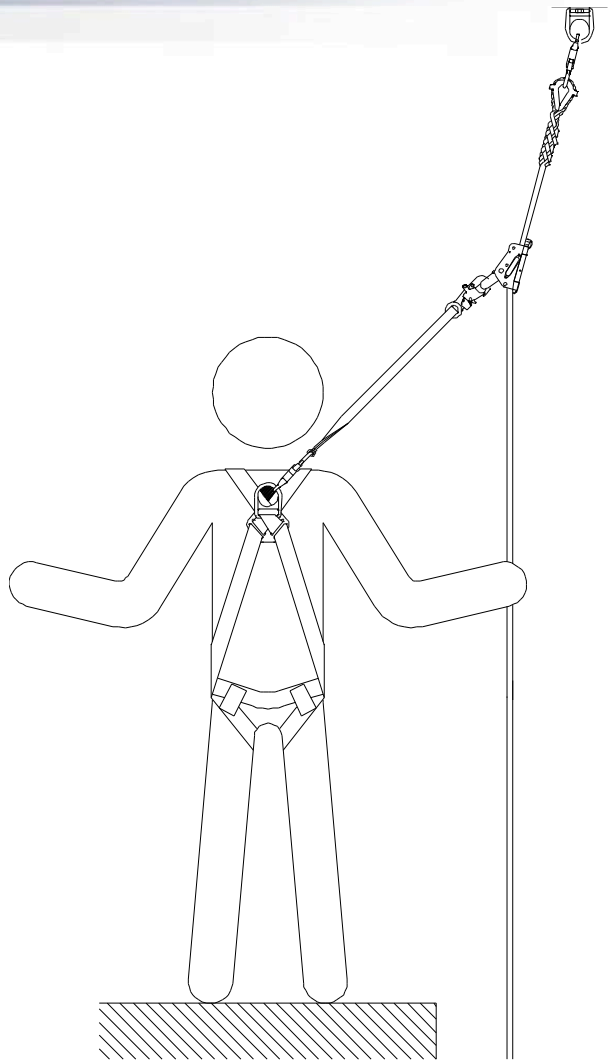
FBH+FACSS System:

FBH Type	FBH Description	Con. Point	FACSS+ Lanyard	Wt (lbs)	FF (ft)	MAF (lbf)	AD (in)	P/F
Vest	PT Buckles	Dorsal	FA+VLL+ Wire rope lanyard	420	7.5	N/A	N/A	P
Vest	PT Buckles	Dorsal	FA+VLL+ Wire rope lanyard	300	6	1371 to 1566	25 to 28	P

Conclusions

FBH + FACSS SYSTEM:

- No damage to system
- Sufficient strength to withstand twice the potential impact energy of fall permitted by system.
- MAF <1800 lbs
- DD < 42 inches
- Special markings: Capacity: 420 lbs



Results

FBH+LSS System:

FBH Type	FBH Description	Con. Point	LSS	Wt (lbs)	FF (ft)	AD (in)	P/F
All	TB/PT/QC Buckles	Front	Wire rope lanyard	300	1.3	N/A	P
Vest	PT Buckles	Front	Cable carrier w/sleeve	300	System 9 in max.	2.3	P

Conclusions

FBH + LSS SYSTEM:

- Dynamic performance
  - Arrest < 6 in (152mm)
- Dynamic Strength (harness component)
  - No release of torso
- Special markings:
  - Capacity: 420 lbs
  - One user per system

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Results

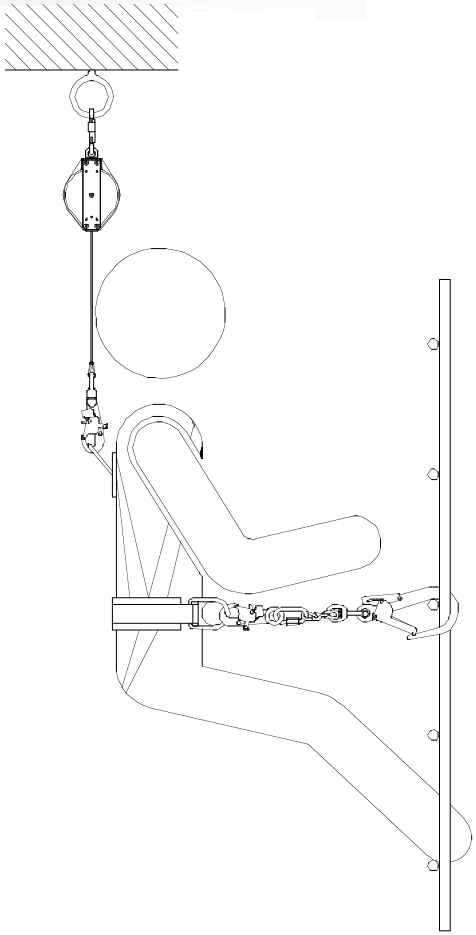
FBH+WPL System:

FBH Type	FBH Description	Con. Point	Lanyard	Wt (lbs)	FF (ft)	P/F
Vest	TB/PT/QC	Hip	Web	340	4.0	P
Vest	TB/QC	Seat	Y-Web	340	4.0	P
X-over	PT	Hip	Web	340	4.0	P
Step-in	TB	Hip	Web	340	4.0	P

Conclusions

FBH + WPL SYSTEM:

- No damage to system
- Sufficient strength to withstand twice the potential impact energy of fall permitted by system.
- Special markings: Capacity: 420 lbs



Conclusions

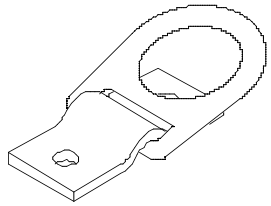
FBH Component:

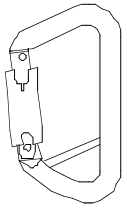
- In each case harness sufficient strength to withstand impact – No release of the torso.
- Little or no damage to webbing or harness stitching. No slippage of adjusters.
- Special markings:
  - Warning: Do not exceed capacity of other system components
  - Capacity definition
  - Capacity: 420 lbs

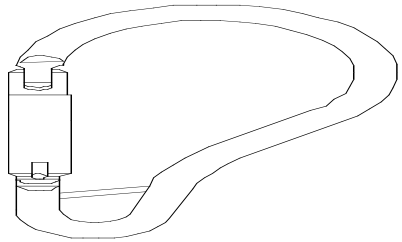
Conclusions

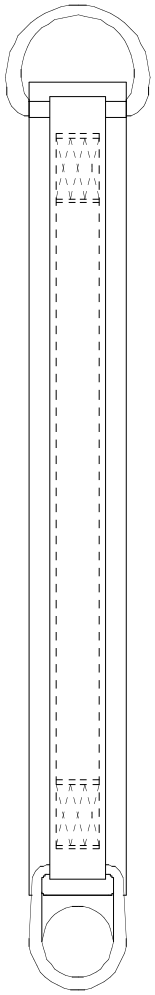
Other system components:

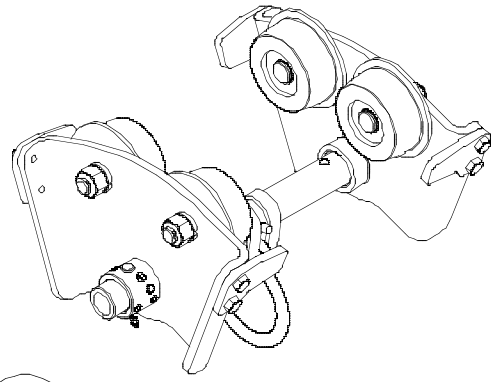
- Connectors
- Anchorage Connectors
- Anchorage
- These system components maintain FOS since MAF ≤1800 lb (8kN)

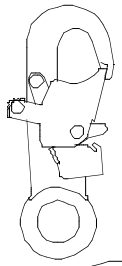


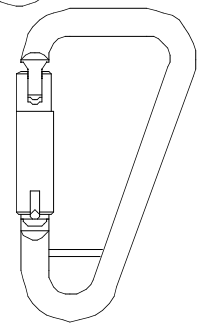


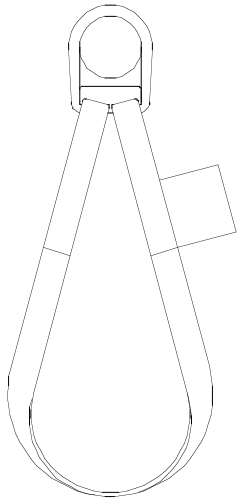












Conclusions

Final Comments:

- Results illustrate the capacity rating is a key guideline for equipment selection and system performance.
- Systems selected meet 420lb capacity evaluation criteria!
- Is this the correct test criteria?

Final Comments

Testing at 1.1 and 1.0 human weight / rigid weight:

System Type	Con. Point	Test Lanyard	Wt (lbs)	FF (ft)	MAF (lbf)	AD (in)
FBH+L+EA	Dorsal	Wire rope	420	6.0	2075 / 2065	68/68
FBH+L+EA	Dorsal	Wire rope	380	6.0	1546 / 1581	65/66
FBH+SRL	Dorsal	50 ft cable	420	“0”	1267 / 1183	27/20
FBH+SRL	Dorsal	11 ft web	420	“0”	1009 / 1042	36/43
FBH+FACSS	Dorsal	Wire rope	420	6.0	1442	40
FBH +LSS	Front	N/A	420	System 9 in max	N/A	4.5 to 6.8

Thank you!

Questions?

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Fall Protection Experts

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