National Safety Council
CONGRESS & EXPO
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Session 94

Three Point Control for Ladders

J. Nigel Ellis, Ph.D., CSP, P.E., CPE

Design for Construction Safety
OSHA Alliance
Ladder Safety

Research on Handholds in industry to support bodyweight by Kurt Beschorner and Justin Young:

“Use Horizontal handholds wherever design permits to promote ladder stability hence safety”

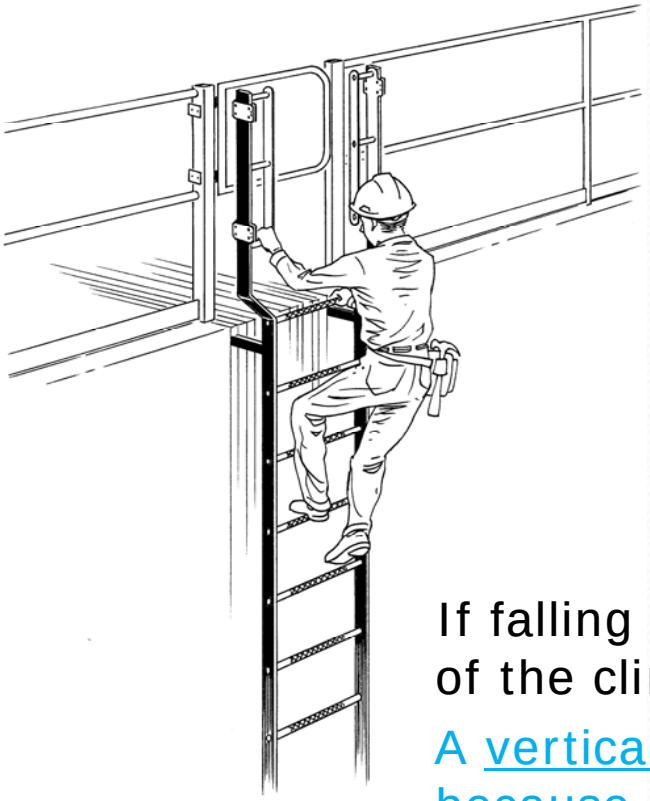
Work/Access by Ladder: Three Point Contact v. Three Point Control

- Contact is a vertical side rail, shoulder or hip for balance only using three limbs; Control is same but …..
- Control is horizontal handholds with known dynamic strength capability, men 120%+ body wt
- Optimum Handhold is 1-1.5” (2.5-3.8 cm) solid rounded horizontal grip

Ref: Professional Safety Journal article: Three Point Control, Nov 2012

119 Ladder-related Deaths in 2014 USA (BLS/USDOL)

Walk-Through
Fixed Ladders
Climbing Principle



If falling starts, a horizontal handhold will hold the weight of the climber:

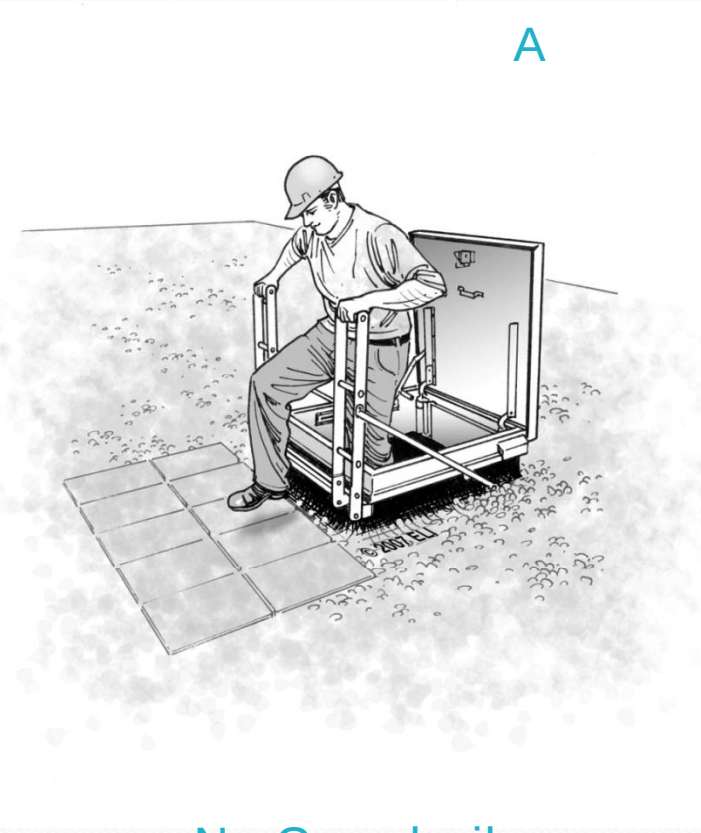
A vertical handhold will not prevent a fall because the hand can slide

Rung size/shape 1-1.5” Rounded (2.5-3.8 cm)

Roof Access: Hatch Walk-in/Walk-out

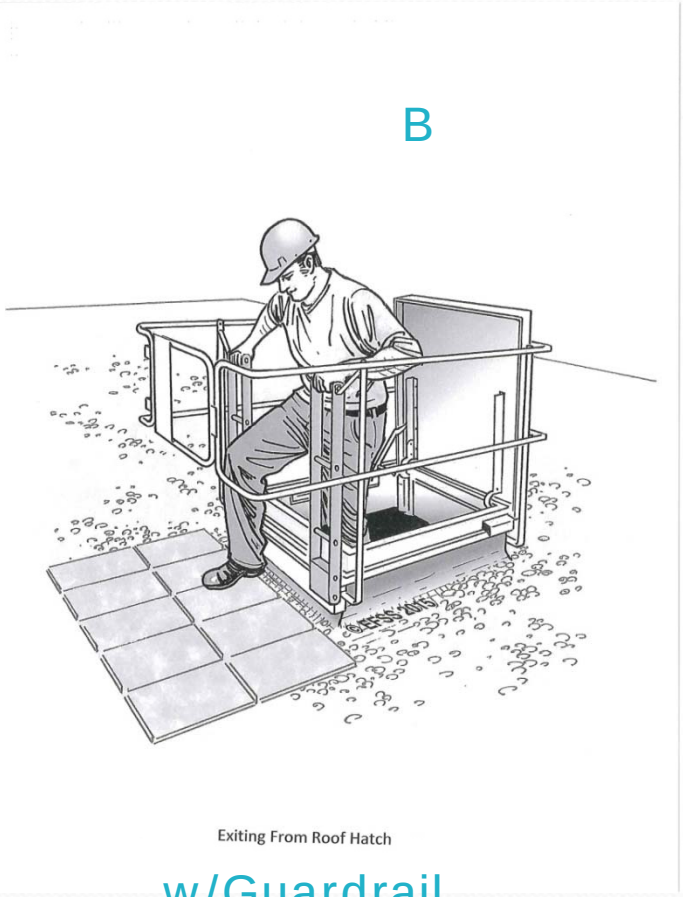
Eliminates Painful, Dangerous Crawl in and crawl out!

A



No Guardrail

B



w/Guardrail

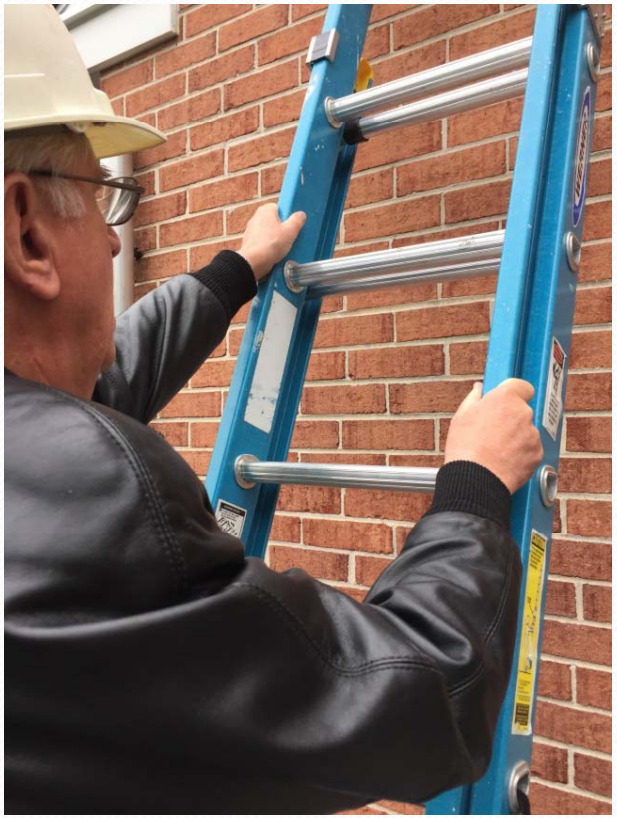
Industry Standard in USA

For all ladders: *Hold Rungs!*

OSHA Alliance Construction Solution 7/2016
Fixed Ladders

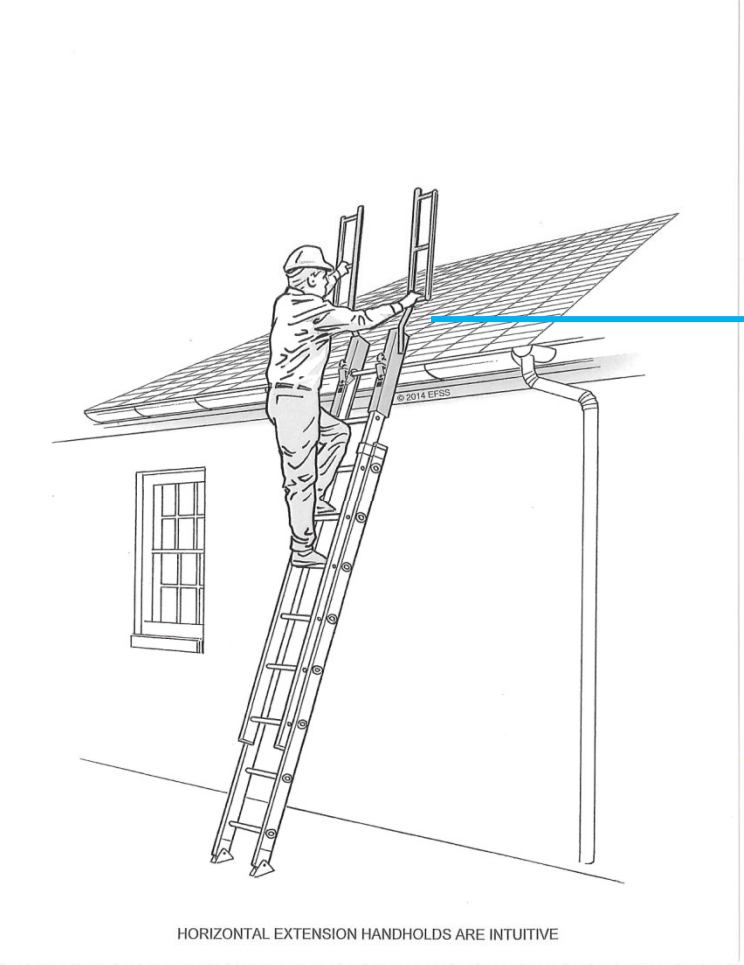
Best Practice

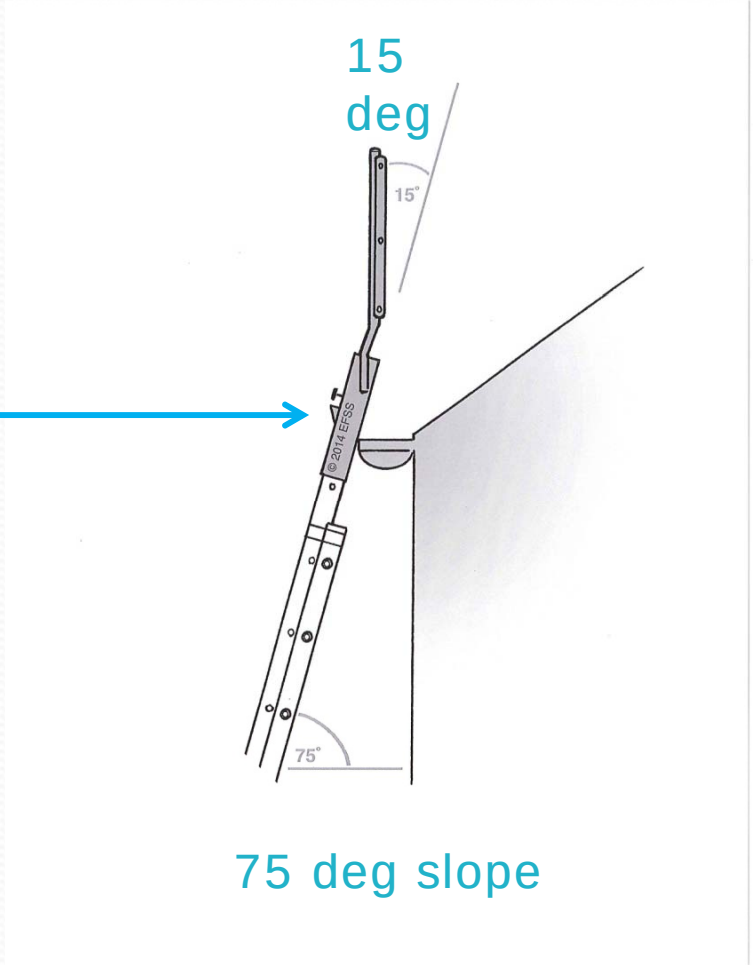
Justin Young thesis: link FallSafety.com



Portable ladder: hold Rungs (right) not SideRails (left)

15 deg. angle helps Ladder Extension act independently of Ladder





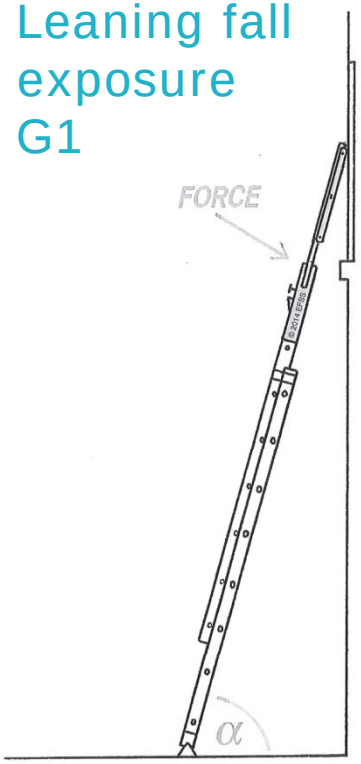
Generation 2 Ladder Extension

Force stays on ladder with 15 deg. slope:

G2 force is at ladder joint not the extension

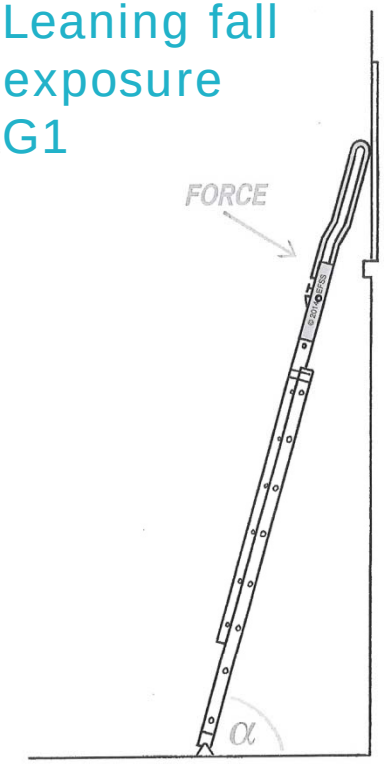
G1 force is at resting point of extension

Leaning fall exposure G1



STRAIGHT LADDER EXTENSION DEFICIENCIES

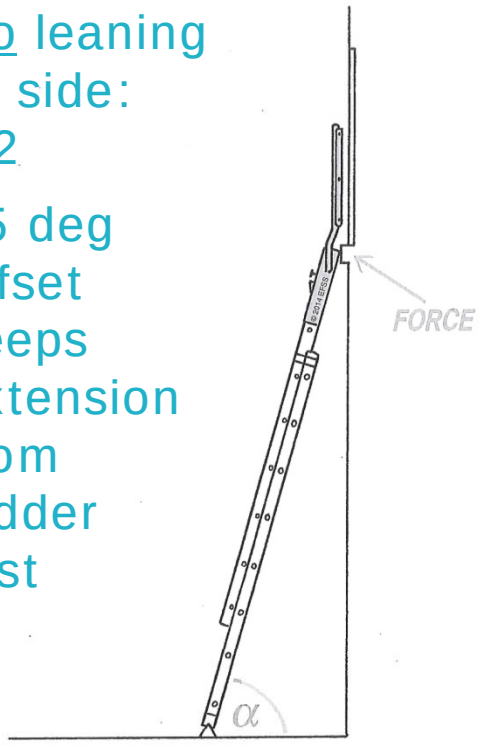
Leaning fall exposure G1



GENERATION ONE LADDER EXTENSION

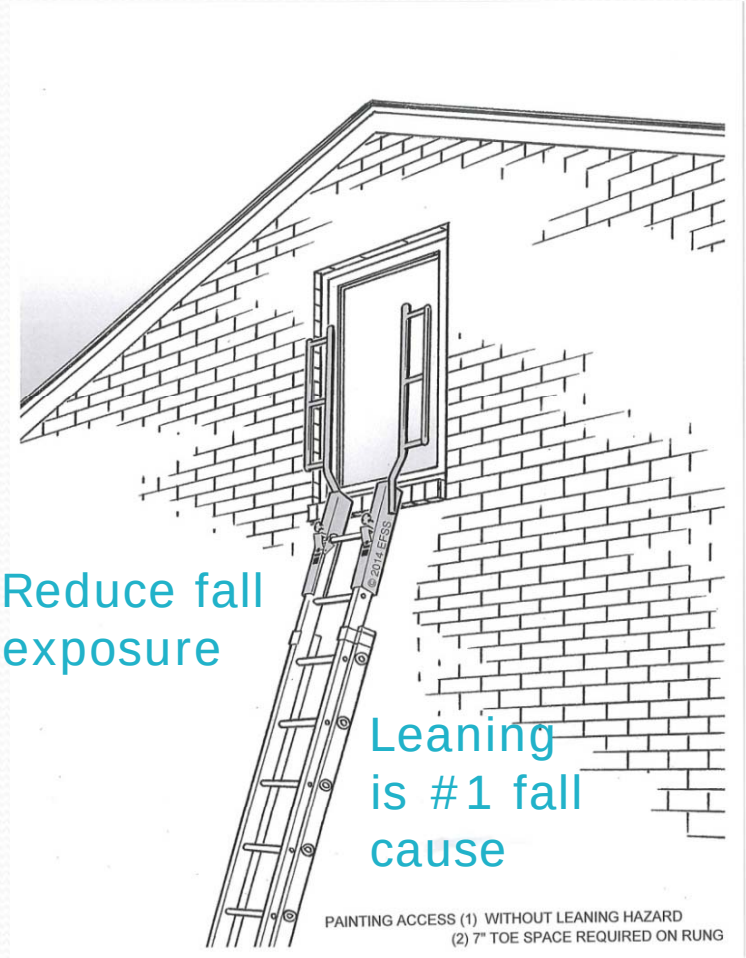
No leaning to side: G2

15 deg offset keeps extension from ladder test



GENERATION TWO LADDER EXTENSION

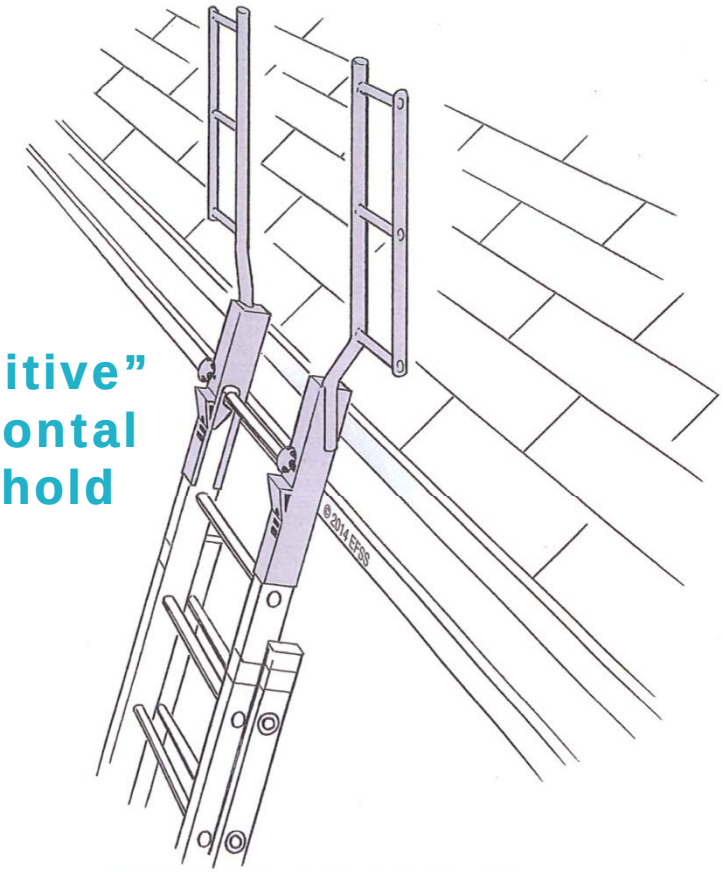
Paint, Caulk etc. without Leaning



Three Point Control G2 Walk-Through Ladder Extension

Extends a ladder by required 3ft
NOTE: 50% + OSHA citations for ladders less than 3ft

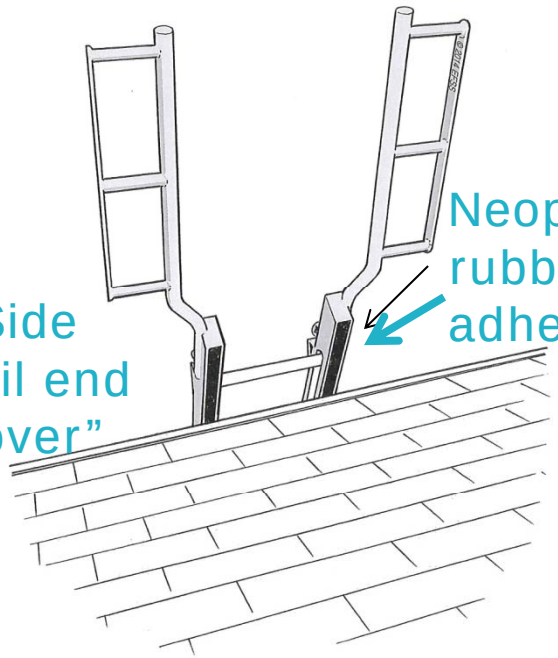
"Intuitive" Horizontal Handhold



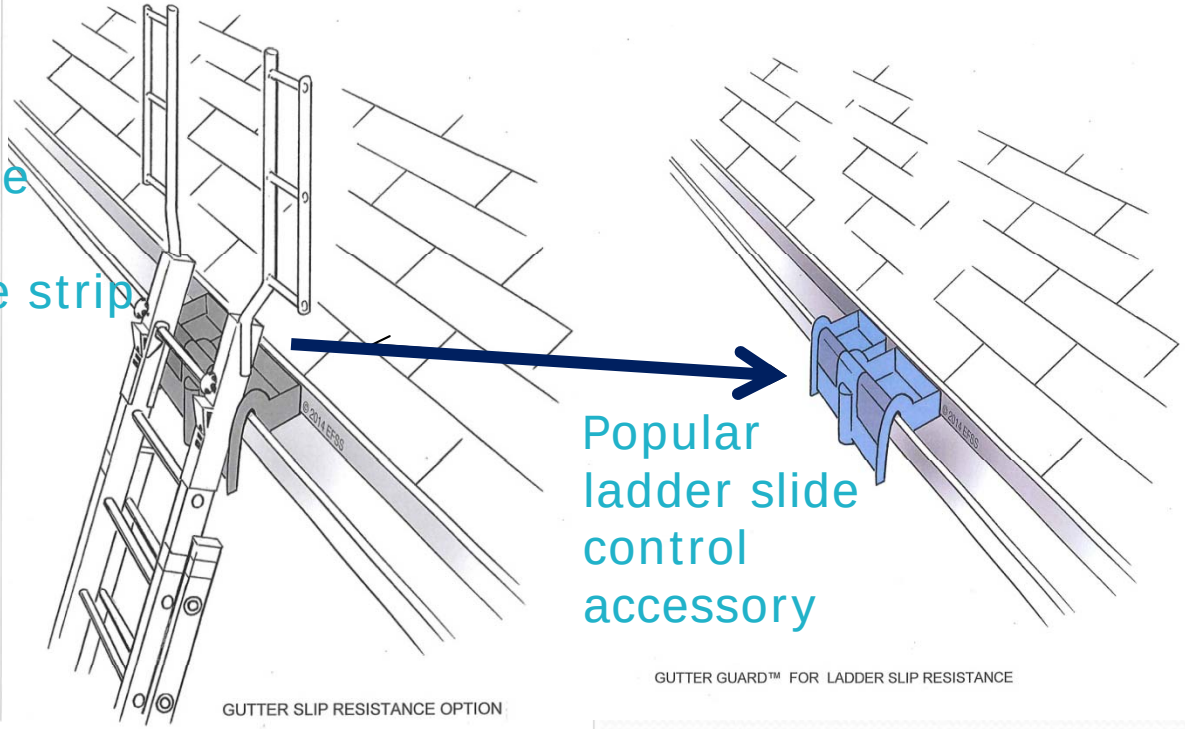
GRABSAFE PORTABLE LADDER EXTENSION GENERATION 2

Tools for Portable Ladder Slide Control

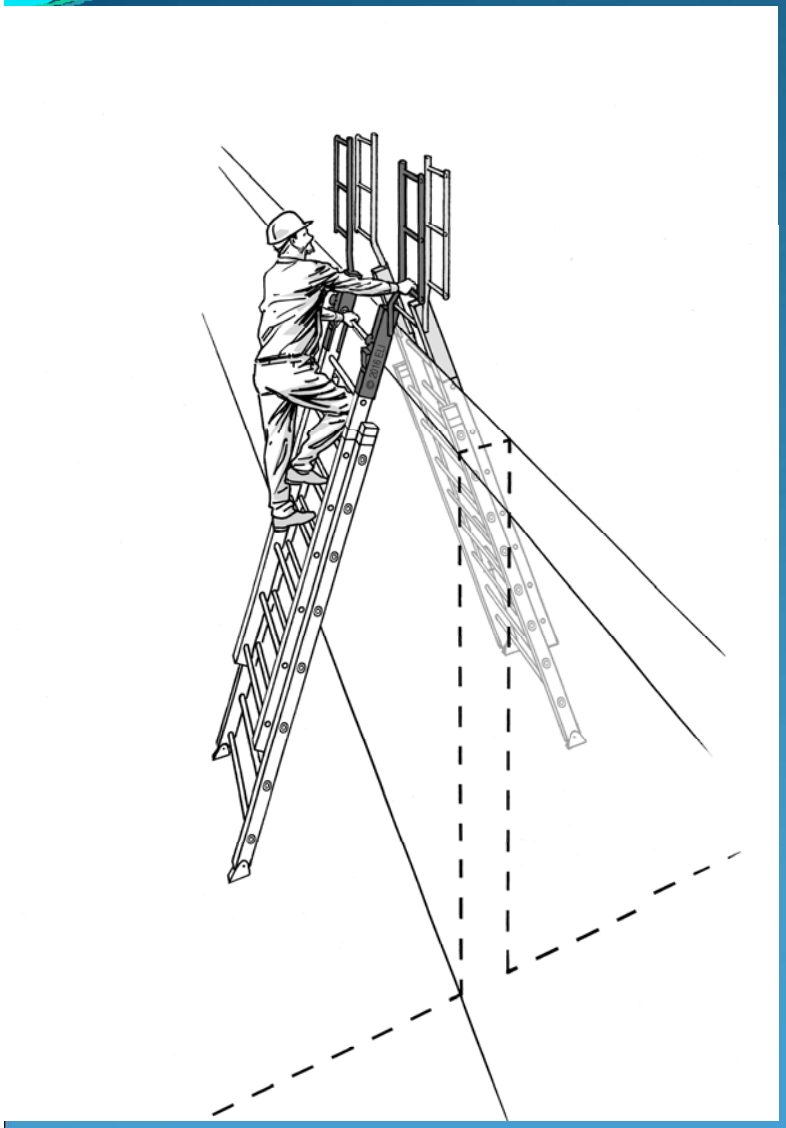
1 Good



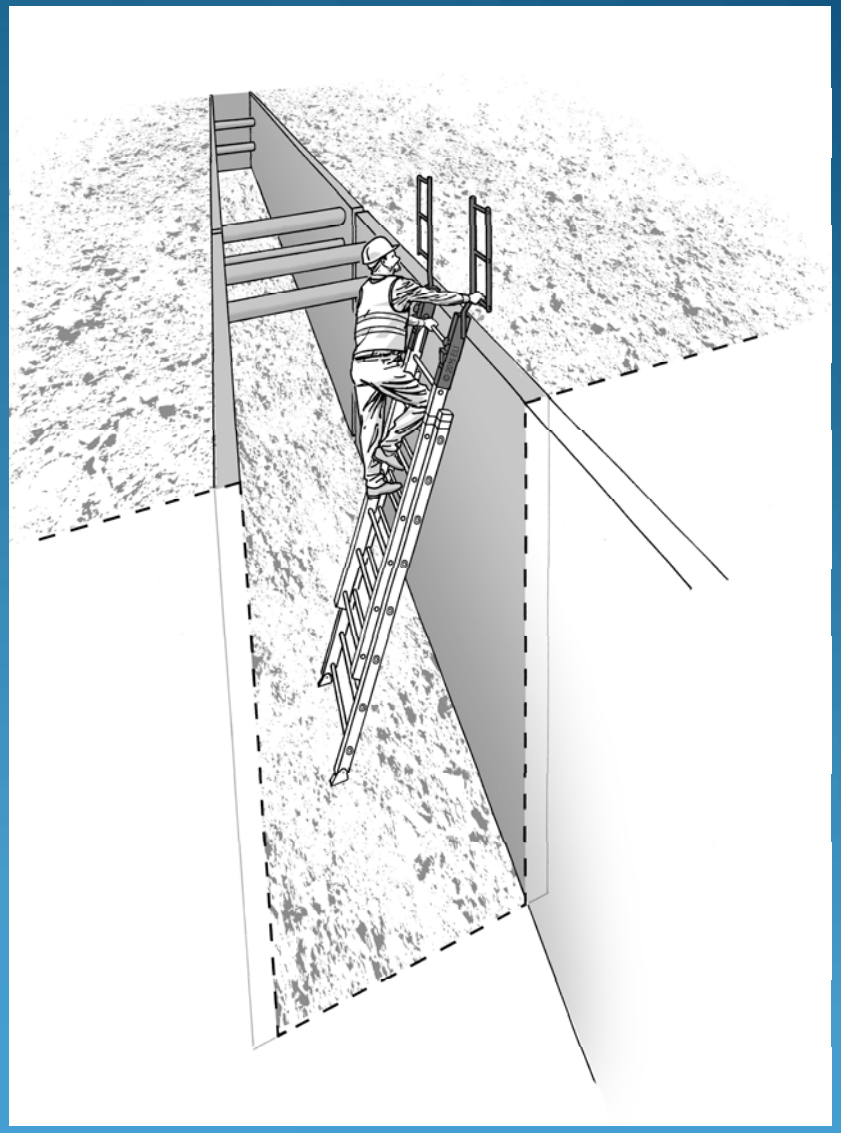
2 Better



Construction Sites



1.Walk-up and over



2.Walk-Through

Testing G2 to ANSI A14.5

Initial testing methodology was taken from A14.5—2007 Fig 4A. The static test was modified from the Fig4. to include the GSP and load test each devise (left and right).

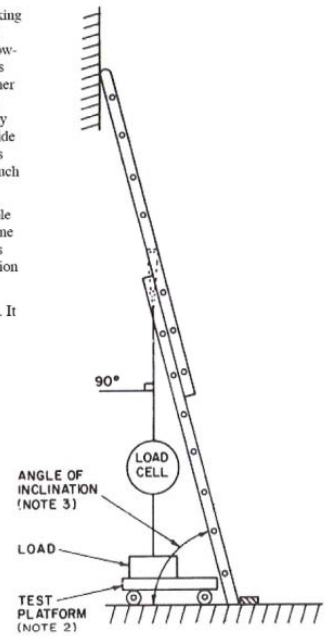
8.3.3 Simulated In-Use Inclined Load Test.
Note: This is a design verification test.

The ladder shall be extended to the maximum working length and supported as shown in Fig. 4. The load shall be applied equally to both side rails on the lowest fly rung above the overlap on extension ladders and at the first rung at midspan or above on all other ladders. The load shall be applied using two 3-1/2 inch straps, each located next to a rail and centrally loaded through an equalizer bar on the climbing side of the ladder. All supporting and loading apparatus shall conform to that shown in Fig. 4 or shall be such as to produce equivalent results.

The ladder shall be loaded in accordance with Table 14. The full load shall be applied for a period of one minute before release. The ladder shall sustain this load without ultimate failure. Permanent deformation (set) shall be allowed.

This test shall be used only for design verification. It shall not be employed for quality control or field inspection purposes.

Figure 4
Inclined Load Test



NOTES:
(1) This illustration shows the test setup before the load is applied.
(2) The test platform follows the test load as the ladder deflects into the wall.
(3) The angle of inclination shall be 75-1/2°, except that for combination ladders in the extension-ladder orientation a slightly modified angle shall be used so that the tread portions of the steps are horizontal (level).

2

1000 lbs test

Weight Cradle #1 = 150lbs
Weight Cradle #2 = 150lbs
Total = 300lbs

5

Summary: Ladder Safety Enhanced

Ladders are:

The Leading Cause of death in US Construction

Ladder Extension helps:

Reduce risk* by Training workers to hold Ladder Rungs and Horizontal Grab Bars

*Design change helps reduce up to one billion unsafe ladder handholds/day by reducing side rail contacts

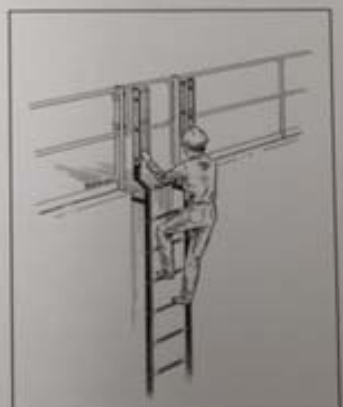
CONSTRUCTION SAFETY DESIGN SOLUTION
DESIGN CATEGORY: Roof Access
HAZARD: Falls from ladders and other climbing structures
DESIGN SOLUTION: Incorporate horizontal grab features for effective three-point control

Fatalities caused by falls from elevation continue to be the leading cause of death for construction workers, accounting for 345 of the 899 construction fatalities recorded in 2014.[1] Falls from ladders make up nearly a third of those deaths.[2] Some of these deaths can be prevented if designers incorporate horizontal grab features to enable workers to more effectively use three-point control when climbing ladders and other structures.

SOLUTIONS

Providing Horizontal Grab Features to Prevent Falls From Ladders

For walk-through fixed ladders, designers should specify that the ladders or ladder equivalent have horizontal round grab bars. If a fall occurs, a vertical rail extension is less effective in stopping the fall due to low sliding friction and lack of a horizontal power grip.[3] However, if a worker is holding rungs on the ladder or equipment or structure horizontal grab bars, sliding is avoided when a fall starts at the top three-foot extension of a fixed ladder during transition due to the high-strength, non-sliding hook grip.



Worker using horizontal grab bars on fixed ladder.

Workers should be trained to hold only horizontal rungs and horizontal grab bars when possible and to use the three-point control climbing technique. See below for a discussion of three-point control versus three-point contact.

Designers of ladder climbing systems should consider human factors when planning the use of effective three-point control. These factors include handgrip strength capacities, the maximum breakaway force if a hand is forcibly pulled away from a support, and the size, shape, orientation, and spacing of handholds/grab bars.

[1] BLS, 2014 Census of Fatal Occupational Injuries.
[2] Falling Off Ladders Can Kill, OSHA Publication 3625 (2015). *See also* CDC, Morbidity and Mortality Weekly Report, Occupational Ladder Fall Injuries – United States 2011 (Apr. 25, 2014) ("Among construction workers, an estimated 81% of fall injuries treated in U.S. emergency departments (EDs) involve a ladder.")
[3] A horizontal power grip refers to holding a rung or horizontal bar, as opposed to holding side rails or vertically placed holds. *See* Barnett and Poczynok (2000). Ladder rung vs. siderail hand grip strategies. Triodyne Safety Brief, 16(4), 1-15. Depending on the rung size, the horizontal power grip can result in a 75-94% larger breakaway force than when gripping a vertical rail of the same shape and size. *See* Young, Woodley, Armstrong, et al. (2012). The effect of handle orientation, size and wearing gloves on the hand/handhold breakaway strength. *Human Factors*, 54(3), 316-333.

OSHA Alliance Three-Point Control link:

http://www.designforconstructionsafety.org/media.shtml

Questions?

J. Nigel Ellis: Author, Textbook:
"*Introduction to Fall Protection,*

4th ed." 600 p., 2015, ASSE

www.FallSafety.com

An Educational Web Site for high work

dsc@FallSafety.com
Ellis Fall Safety Solutions LLC

Ref: Work of Justin Young, UMICH, NIOSH grant
Work of Kurt Beschorner, UPITT, NIOSH grant

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