

Rescue Technician – Basic & Confined Space Technician

Session 1





Suffolk County Fire Academy

1

House-Keeping

- Instructors
- Students
- Paperwork
- Student Manuals
- Exits
- Cell Phones and Pagers.




2

Course Overview

5 Sessions


- **Session 1**
 - Rope Analysis
 - Rescue Knots
 - Equipment Identification
 - Patient Packaging
 - Anchoring
 - Hands-on Stations.



3

Course Objectives (RTB)


- Conduct a size-up of a rescue incident, including a rope rescue incident, to identify potential hazards to victims and rescuers (NFPA 1006 5.1.2, 5.1.3, 5.2.1)
- Identify different types of PPE as well as rescue rope and equipment and explain its use, care, and maintenance (NFPA 1006 5.2.2, 5.2.3)
- Demonstrate knots, bends, and hitches using rescue rope and webbing (NFPA 1006 5.2.4)
- Describe the components of a substantial anchor, both single point and multi-point, and demonstrate their use in a rope rescue system (NFPA 1006 5.2.5, 5.2.6)
- Identify the components of a system safety check conducted prior to life-loading a rope rescue system (NFPA 1006 5.2.7).



4

Course Objectives (RTB) Cont'd


- Define edge protection and demonstrate its use in a rope rescue system (NFPA 1006 5.2.8)
- Construct and operate a system intended to provide belay (Safety) within a single or two-tensioned rope system (NFPA 5.2.9, 5.2.10)
- Construct and operate a lowering system (Main) (NFPA 1006 5.2.13)
- Construct and operate a simple rope mechanical advantage system (Haul) (NFPA 1006 5.2.15)
- Describe and demonstrate the transfer of a victim to a packaging system appropriate for the victim and their injuries (NFPA 1006 5.2.20).



5

Course Objectives (RTB) Cont'd


- Conduct a litter-lowering and litter-raising operation in a low-angle environment (NFPA 1006 5.2.21)
- Operate as a litter tender in a low-angle lowering or raising operation (NFPA 1006 5.2.22)
- Identify potential landing zones (LZs) and hellspots (NFPA 1006 16.1.2)
- Discuss the hazards associated with helicopter operations (NFPA 1006 16.1.4)
- Assemble a portable anchor system for application of a high-point of attachment (NFPA 1670 7.2.12).



6

Session Objectives

- Identify different types of rescue rope and explain its use, care, and maintenance
- Demonstrate the tying of rescue knots and explain their use in rope rescue systems
- Name various rope rescue equipment and describe their use
- Describe the components of a substantial anchor
- Describe various patient package devices and methods.



7

ROPE ANALYSIS





8

NFPA 1983 Safety Margins

ONE PERSON LOAD = 300 LBS
TWO PERSON LOAD = 600 LBS

LIFE SAVING ROPE = 15:1 SAFETY MARGIN

300 lbs. X 15 = 4,500 LBS
600 lbs. X 15 = 9,000 LBS
1/2" (12.7 mm) DIAMETER





9

Kernmantle Rope Construction

KERN or "CORE" – Primary Load
75% - 85% of the load

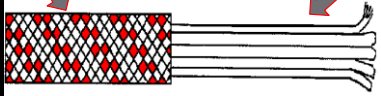

MANTLE or "SHEATH" – Outer Braid
15% - 25% of the load.



10

Static Kernmantle

Mantle (SHEATH) **Kern (CORE)**

11

Static Kernmantle

- Better Control
- Low Stretch
 - 2% at 200 lbs.
 - 20% at failure
- Are Colors Important?




12

O.O.S.

- Sheath Penetration
- Severe Shock Load
5' - One person load
- Chemical Contamination
Acids, Chlorine, Bleach
- Soft, Mushy, or Hard Spots
Not Recoverable By Popping
- Age
5 Years From Date of Manufacturer
- Anytime Doubt Exists.




13

Protect Your Edge

IMPROPER EDGE PROTECTION

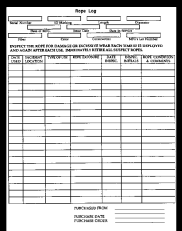

THE CAUSE OF 90% OF ALL ROPE FAILURES




14

Care, Maintenance, and Storage of Rope



- Inspect After Each Use
- Inspect Rope Monthly
- Store Rope In Proper Size Rope Bag
- Store Away From Fumes, Greases, Etc.
- DO NOT OVER PACK
- DOCUMENT ALL INSPECTIONS AND USAGE.

15

Protect Rope From UV Radiation

- Sun
- Fluorescent Lights
- Use A Rope Bag.



16

Safe Operations Around Rope

- Safety Lines Are Required At All Times
- Do Not Walk or Stand On The Rope
- Do Not Smoke Near The Rope or Equipment
- Control The Equipment – Do Not Throw or Drop
- No Knives!!!



17

“Popping” Rope Inspection



18

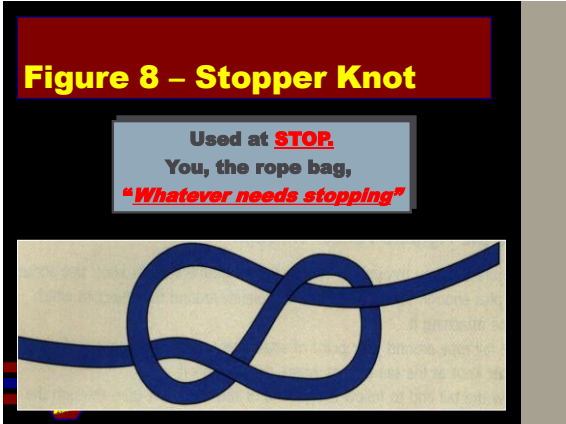


19

Knot Breaking Strengths

	Strength In lbs.	Percent Lost
ROPE	10,750	---
Figure 8	8,640	19%
Double Fisherman	8,440	21%
Figure 8 on a Bight	8,560	20%
Figure 8 Follow Through	8,640	19%
Double Loop Figure 8	8,820	18%
Bowline	7,180	33%
WEBBING	4,800	---
Water Knot	3,060	36%
Overhand Knot	5,128	35%

20



21

Figure 8 On A Bight

- Primarily Used For Anchor Systems And Attaching Into The Rope

22

Figure 8 Follow Through

- Used To Tie Around An Anchor OR Through A Point and Around

23

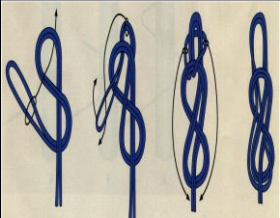

Figure 8 On A Bend

- Used To Join Two Ropes Together

24

Double Looped Figure 8

- Stronger Version of 8 on Bight
- Used To Anchor OR As An Attachment Point

25

Overhand Knot

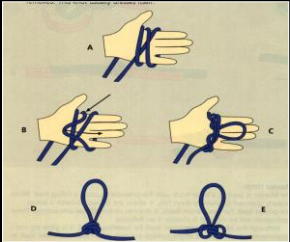
- Can Be Used As A Safety OR To Terminate The Dead End of The Rope




26

Butterfly Knot

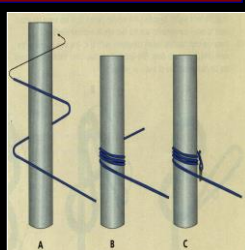
- Used To Create A Loop In The Middle of The Rope For An Attachment Point In A Three Directional Pull






27

Tensionless Wrap

- Minimum of Three Wraps
- Number of Wraps Depends On Anchor Size
- Maintains 100% Rope Strength.

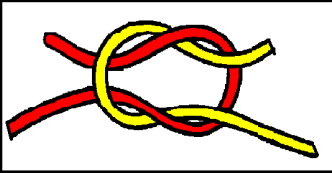







28

Square Knot

- Used To Join Two Liked Size Ropes Together





29



Clove Hitch

Slip Over



In Line



30

Handcuff Knot

- Used For Rapid Victim Removal




31

Munter Hitch

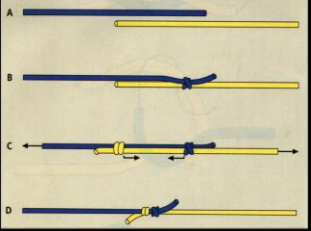

- Belay Line
- Use X-Large Carabiner




32

Double Fishermen's Knot

- Connects Two Ropes OR Rope Into A Loop (Prusik Cord)
- Triple Wrapped Used In Tandem Belay (Safety)

33

Prussik Cord / Loop

34

Prusik Loop Diameter and Uses

- 6 MM
 - Personal use
 - Ascending and self rescue
- 7 MM
 - Personal use and rigging
- 8 and 9 MM
 - System applications
 - Shock absorbers, clutch systems, safeties.

35

Prusik Loop

- Useful As A Rope Grab
- Will Not Damage Rope
- “CLUTCHES” Rope Preventing Failure
- *SELF RESCUE*
- In Tandem For Rescue Loads.

36

Prusik Loop Lengths


- SMALL - 5 FEET
- MEDIUM - 6 FEET
- LARGE - 8 FEET.




37

Webbing

- 1" Tubular (Spiral Weave Construction)
- 4,000 lbs. - End to End
- 6,000 lbs. - When Tied in a Loop
- 12,000 lbs. - Looped and Doubled
- Does Not Take Shock Well - Allows Little Stretch
- Should Be Replaced Often.



38


Water Knot




39

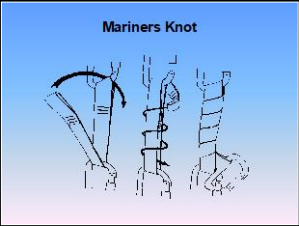
Care For Webbing

- Same as RESCUE ROPE
- Look For Glazed Areas
- Remember:
 Single Pull Rating 4,000 lbs. End to End
 Looped - 6,000 lbs.
 Looped and Doubled - 12,000 lbs.
- Usually Needs Replacing More Often.




40

Mariners Hitch



Mariners Knot



41

EQUIPMENT
IDENTIFICATION



42

Equipment and Hardware


- Carabiners
- Descent Control Devices
- Pulleys
- Ascenders
- Accessories
- **EDGE PROTECTION.**



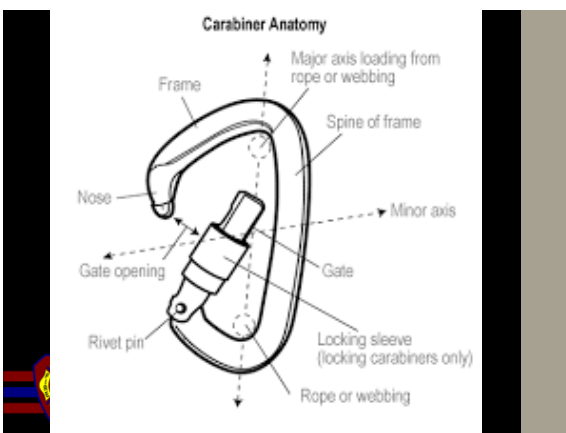

43

Carabiners

- Connect Pieces of the Rope System Together
- AKA: Snap Links or “Biners”
- Have A Spring-Loaded Gate
- Most Have A Locking Feature
- Modified “D” – Loads To The Spine Side.




44



45

Carabiners - Two Types


- **Personal Use**
 - Carabiners and snap links have a minimum breaking strength of 6,000 lbs.
- **General Use (G-Rated)**
 - Carabiners and snap links have a minimum breaking strength \geq 9,000 lbs.
- **Which Do We Use In Our Systems? Why?**



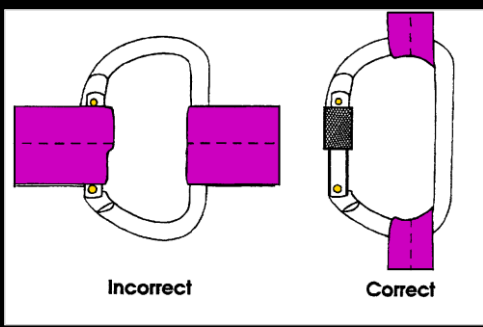
46

"D" Carabiners


- **9,000 lbs. When Loaded Along Spine Axis**
- **When Loaded Along Gate Axis The Strength Is Greatly Reduced**
- **NFPA Requires That A Locked, Side Loaded Carabiner Must Be Able To Hold 2,400 lbs.**



47



Incorrect Correct



48

**Lock Configuration
"Pin Latch"**

- Pin-Lock Prevents Gate From Opening Under High Stress
- Loses 10% – 15% of Strength When Unlocked
- Used In All High Angle and Confined Space Equipment
- Inspection – Ease of Operation and Cracks
- **Lock Them Finger Tight.**



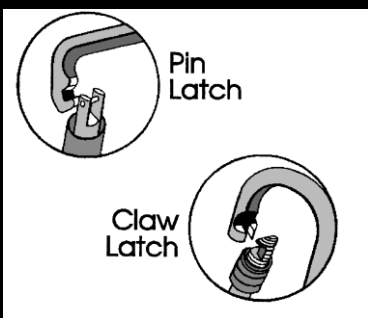
49

**Lock Configuration
"Claw Latch"**

- Gate Matching Mechanism That Holds The Gate In-Line With The Latch
- Loses 50% to 90% of Strength When Unlocked
- **Definitely Lock Them.**




50



Pin Latch

Claw Latch



51

Bull Ring



- Strongest Piece Of Hardware
- Used As The Connection Point For A Bridle
- Solid Steel Construction.



52

Triangle Screw Links (Tri-links)

- Multi-directional Pulls
- Steel Screw Version For Rescue (9,000 lbs. rating)
- Sleeve (Screw Link) Finger Tightened Completely To Maintain Integrity of Link
- May Need Wrench To Open Link Once It Has Been Loaded
- Store With Screw Link Closed.



53



54

Descent Control Devices (DCD)


- Must Have A Minimum Test Strength \geq 1,200 lbs. Without Permanent Damage
- Uses Friction To Control Decent
- Descent Is A Function of Gravity
- Energy/Heat = Slower Descent.



55

Rescue 8 Plate

- Used To Be The Most Common DCD Used
- “Ears” Prevent Girth Hitches and Aid In Lock-off
- Rappelling
- Lowering (One Person Load)
- Progress Capture During Hauling.



56



57

Rescue 8 Plate Limitations

- Limited To 100' Rappels
- Imparts Spin To Rope
- Once On Rope, Friction Is Not Adjustable
- Hard Coat Edges Get Sharp When Worn
- Not Self-minding.



58

Rappel Rack

- Rack = "Cold Rolled" Stainless Steel
- Bars = Aluminum (More Friction/Control)
- Top Bar - 1" Diameter w/ Grooved Slot (Allows Rope To Stay Centered)
- 2nd Bar - Rigging Notch (Will Drop If Rigged Incorrectly)
- 6 Bars Total
- Always Lock Off While On Six Bars
- Rated @ 10,000 lbs.



59

Rappel Rack

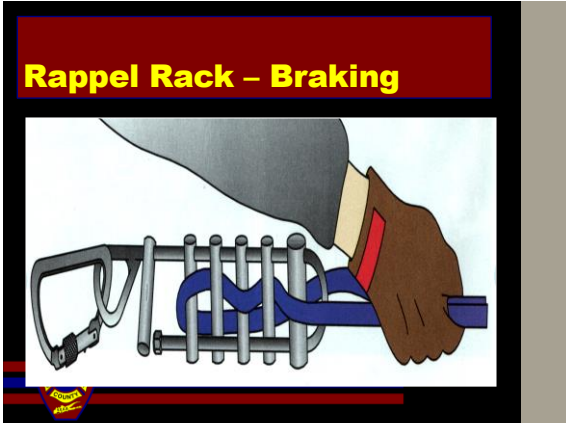
- Positives
 - Variable friction even when loaded
 - Dissipates heat well
 - Versatile for rescue rappelling, lowering, & belaying
- Negatives
 - Bulky / heavier
 - Move involved to rig
 - If over-stressed, fails at the base of eye.



60



61



62

Multi-Purpose Device (MPD)

- Variable-Friction Descent Control Device
- Can Be Used As A Rappelling Or Lowering/Raising Device
- Can Switch Between Lowering And Hauling Without Additional Equipment
- Self-minding
- Rated For A Two Person Load.

63

Multi-Purpose Device (MPD)




64

Petzl I'D

- Self-braking Descender
- Can Be Used As A Rappelling Or Lowering/Raising Device
- Can Switch Between Lowering And Hauling Without Additional Equipment
- Self-minding
- Rated For A Two Person Load.



65

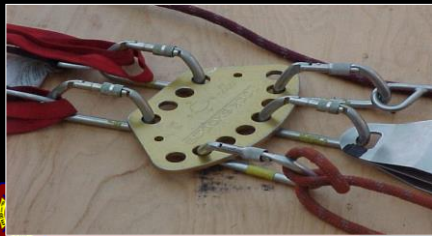
Petzl I'D




66

Anchor Plate

- Used As Attachment Point To Organize System (Line Management!)



67

Pulleys

- Change Direction of Rope
- Assemble M/A System
- Sheave Diameter \geq 4x's The Diameter of Rope (4:1 Rule)
- Double Pulley May Be Used As A Single Pulley
- All Side Plates Must Be Secured Together.



68

Pulleys

- Stainless Steel Side Plates
- Steel Axles
- Oillite Bronze Bushings
- 4" Single = 11,450 lbs.
- 2" Double = 11,300 lbs.
- 4" Double = 16,250 lbs.



69



70

Prusik Minding Pulley

- Aluminum Alloy Side Plates
- Sealed Ball Bearings
- Main Eye Accepts 3 Carabiners
- Rated @ 9,000 lbs.

71


← To Load

Load Long, Short, Pulley, On The Spine of The Biner

72

Knot Passing Pulley

- Designed To Pass Knots Made In 1/2" Rope
- Can Be Used As An Edge Roller (When Secured At The Edge Using Bottom Carabiner Holes)
- 2,000 lbs. Working Load (Above That The Sheave Will Not Turn)
- Oilite Bronze Bearing.




73




74

Ascender (Rope Grab Device)


- System Component Used To Grasp Rope To Support A Load
- NFPA 1983 Requires 2,400 lbs. Force Without Permanent Damage To Rope
- 1/2" Steel Version Rated @ 5,400 lbs.
- AKA - Gibbs (Trade Name).



75

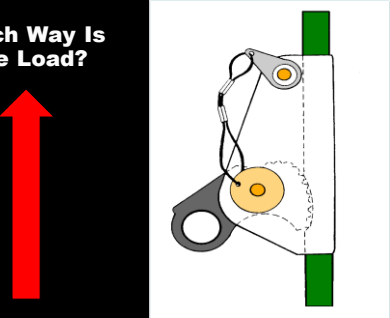

Ascender – Use

- Shell Attached To Rope, Arrow Points In The Direction of Free Travel (Usually Pointing In Direction of Load)
- Stainless Steel Screw In Cam Should Face The Same Side As The Word “UP” Inscribed In The Shell.



76


Which Way Is The Load?

77

Shock Absorber (Screamer)

- Tensile Strength = Approx. 6,000 lbs.
- Activates Between 400 lbs. – 600 lbs.
- Designed To Prevent Injury To Person It Is Attached
- Primarily Used With Safety (Belay) Line
- Attached Between Rescuer And/or Victim And Safety Line
- Between Safety Line And Litter Bridle.



78



79

Swivel

- Rated @ 8,000 lbs.
- Rotates 360°
- Holds Up To Three Carabiners
- Useful In Stairway Lower
- Inspect Before Use For Full And Easy Rotation.

80



81

**Utility Strap
(Anchor Strap)**

- **Constructed of 2" Flat, Weaved Webbing**
- **Rated @ 5,000 lbs. – D-Ring To D-Ring**
- **Rated @ 9,000 lbs. – Looped & Doubled**
- **Must Be Looped & Doubled When Used In Anchor Rigging. Why?**
- **May Be Adjustable.**




82




83

Edge Protection

- **Dynamic Protection**
 - **Moving**
 - **Pulley, Rollers**
- **Static Protection**
 - **Non-Moving**
 - **Padding, Carpet, Canvas, Turn-Out Coat**



84



85



86

Patient Removal Devices


- **Harness Type Devices**
 - Full body harness
 - Wristlets
 - LSP Half-back™ type device
- **Stretcher Type Devices**
 - Stokes basket stretcher
 - SKED™ type device
 - Miller Board™ type device
 - Res-Q-Mate™ type device
 - Reeves Sleeve.



87

Patient Packaging (General Sequence)




1. Put Patient On A Long Board
2. Diaper Harness - Vertical / Horizontal
3. Diamond Lash Patient To The Board
4. Place Patient Into Device - Stokes / Sked
5. Diamond Lash Patient Into Device
6. Bridle For Lift - Vertical / Horizontal
7. Attachment To Safety
8. Attachment To Main Line.



88

Stokes Basket


- Steel Construction
- Preferred Device For Vertical & Horizontal Patient Removal
- Can Be Used With A Back Board
- Provides The Best Level of Spinal Immobilization
- Do Not Confuse With Orange Stokes Used For RIT.

89

Diamond Lashing

- 36' of 1" Tubular Webbing
- Tighten Down Lashing Securely
- Do Not Lash Horizontally Across Upper Chest Near The Neck Area
- Clove Hitches Used At Head of Stokes
- Girth Hitch At Base of Stokes.

90

SKED Stretcher

- Plastic Sheet Construction
- Preferred For Confined Space
- Can Be Used As A Sled For Dragging
- Can Be Oriented For Vertical Or Horizontal Use

SHOULD ALWAYS BE USED WITH A BACKBOARD.



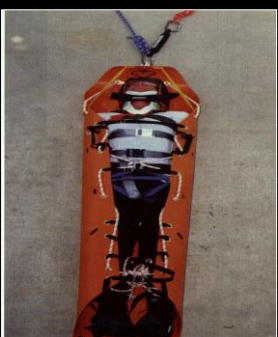

91

SKED






92

Patient MUST be securely lashed to a backboard serving as the primary means of immobilization while being transported in the SKED.

93



- Nylon Webbing Straps Rated At 3,800 lbs. Each
- Head Strap 4" Shorter Than Foot Strap. Only To Be Used At Head.

94

Full Body Harness (Diaper Seat)

- Made From Webbing 24' - 30'
- Used On A Patient Without Suspected Spinal Injury
- Can Be Used For Rapid Egress When Space Is Limited and Time Is Of The Essence.

95

LSP Half-back

- Used In Tight Areas
- Modified Class 3 Harness
- Rated Lifting Device
- Provides Limited Spinal Immobilization.




96



97



98




99

Anchors

- Anchors Are The Foundation of The System
- Most Are Questionable At Best
- Things Are Not Always What They Appear To Be
- Multiple Weak Anchors ≠ Strong

BACK THEM UP!



100

Anchor Attachments

- Know Your Equipment
- Keep Rope System **SIMPLE**
- Use "Tensionless" Attachments Where Possible
- Equalize Webbing Bites
- Reduced Rope Length To Anchor = Reduced Shock Loads


TAKE PRIDE IN YOUR KNOTS.



101

Rigging / Bombproof


- **Definition:**
 - If a bombproof anchor were to fail, it would cause the collapse of the entire structure.
- Back Up The **RIGGING** of Primary Attachment Point of A Bombproof Anchor
- If There Is Any Question By Any Member of The Team, **BACK IT UP.**



102

Secondary Anchor


- Secondary Equal To Or As Strong As Primary Anchor
- As Much As Possible, Directly Behind And In Line With Primary Anchor
- Secondary Not Positioned Behind May Cause Serious Shock Load To Primary.



103

Proper Anchors (Structural Steel)


- Steel Beams & Beam Projections
- Stairwell Support **BEAMS**
- DAVITS (Small Crane Arm For Hoisting).



104

Proper Anchors (Bulk Concrete)

- Structural Concrete Columns
- Supports For Large Machinery
- Brickwork With Large Bulk (i.e. Corner Wall)
- Window Washer Eye Bolts (**Must Be Backed Up**).



105

Proper Anchors – Motor Vehicles

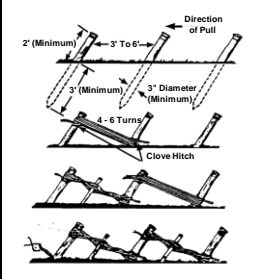
- Set Parking Brake
- Chock Front And Rear Wheels
- Transmission
 - Automatic = Park Manual = Reverse
- Remove Keys / Emergency Vehicle With No Keys Having Master Switch = Lights And Siren In On Position
- Anchor To Structural Parts of Vehicle / No Sharp Edges, Grease, Oil, Etc.



106

Picket Holdfast

- Drive Pickets (Steel or Wood) Into Ground 15° Minimum From Vertical
- Lash Pickets Together Starting At Top of First Picket
- Twist Rope With Rack Stick, Then Drive Into Ground.



107

Improper Anchors

- Insulated Pipe
- Handrails
- Cast Iron Pipe
- Corroded Metals
- Brickwork Without Bulk
- There Are Many,



KNOW YOUR ANCHORS!



108

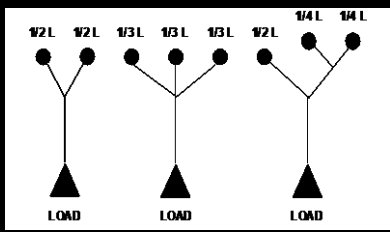
Directionals

- Technique For Redirecting The Path of A Rope To A More Desirable Angle.
- Create Bridle From Webbing Or Rope (Butterfly Knot) For Attachment To Your Line.



109

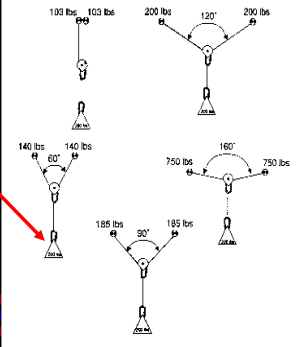
Variations In Anchor Point Loads



110

Critical Forces

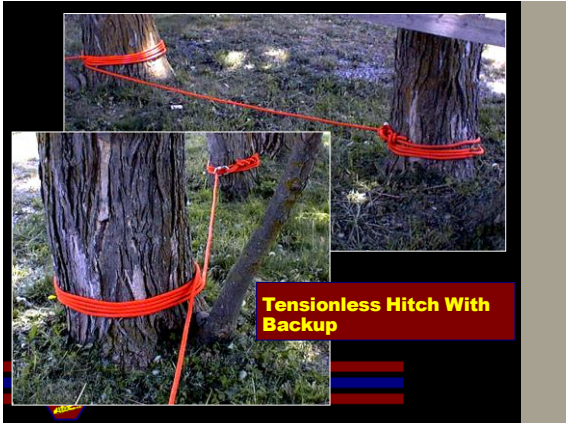
- 120° And Below
- 120° And Above
- 60° Is Optimal
- 200 lb. Weight



111



112



113



114



115



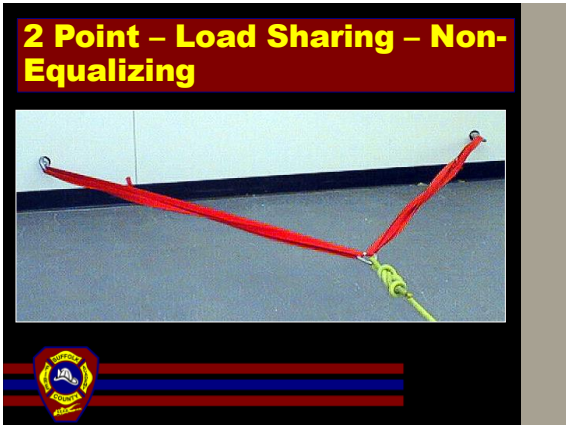
116



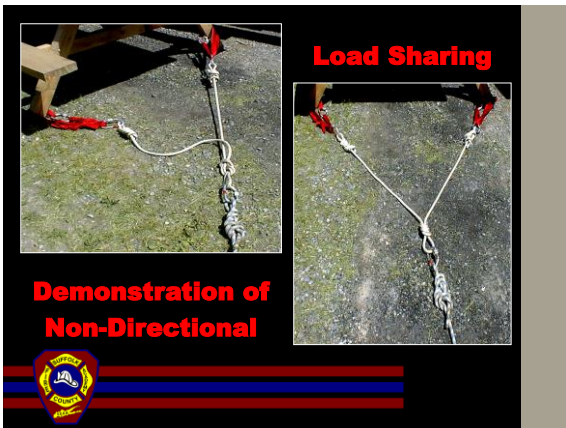
117



118



119



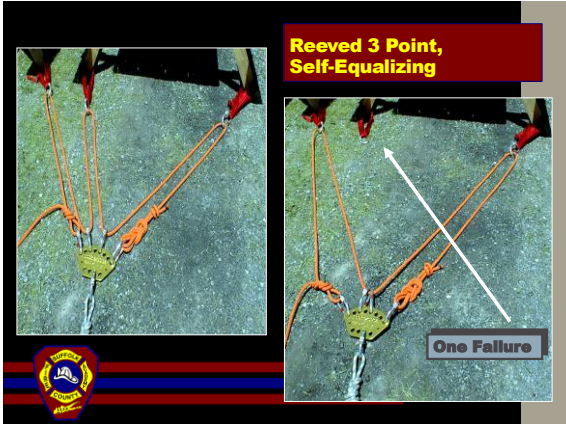
120



121



122



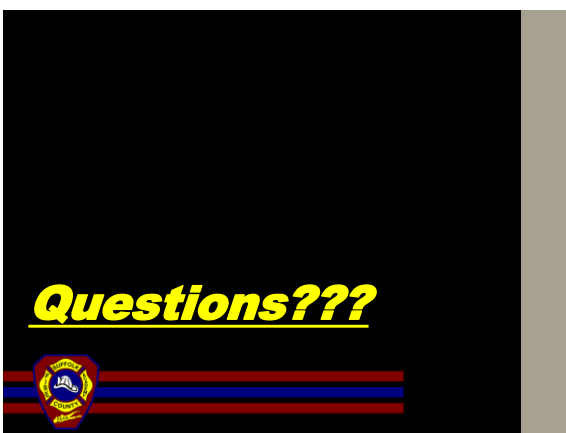
123



124



125



126
