

Suffolk County Fire Academy
Rope Rescue Operations





Suffolk County Fire Academy

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Course Overview

- **Session 2**
 - **NFPA Standards**
 - **Incident Command System**
 - **Equipment Overview**
 - **Rope Rescue Systems**
 - Anchoring
 - Belaying
 - Mechanical Advantage Systems
 - Lowering / Hauling
 - **Patient Packaging**
 - **Hands-on Evolutions.**



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Session Objectives
Session 2

- **Identify the NFPA standards which address rope rescue and describe their application in rope rescue procedures**
- **Define the Incident Command system and describe its use during rope rescue incidents**
- **Demonstrate an understanding of ropes and other specialized equipment used in urban/suburban vertical rope rescue and the correct procedures for the use and maintenance of that equipment**
- **Demonstrate an understanding of anchors, their selection and construction.**

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Session Objectives (Cont'd)

- Demonstrate the acceptable techniques for belaying one or more rescuers or patients
- Construct a mechanical advantage system for given rescue situations requiring various load capabilities
- Demonstrate proper patient packaging, handling, raising and lowering techniques
- Perform a lowering operation with an attendant
- Perform a raising operation with an attendant.

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NFPA Standards



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NFPA Standards


- **NFPA 1670** – Standard On Operations and Training For Technical Search and Rescue Incidents
- **NFPA 1006** – Standard For Technical Rescue Personnel Professional Qualifications
- **NFPA 1983** – Standard On Life Safety Rope and Equipment For Emergency Services



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NFPA 1670
Standard On Operations and Training For
Technical Search and Rescue Incidents

- **Addresses Technical Rescue Disciplines (Including Rope)**
- **Identifies and Establishes Levels of Training**
 - Awareness
 - **Operations** ←
 - Technician.



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NFPA 1006
Standard For Technical Rescue Personnel
Professional Qualifications


- **Rope Rescue Operations Level**
 - Size-up rescue incident
 - Inspect and maintain equipment
 - Tie and utilize rescue knots
 - Construct single and multi-point anchor system
 - Construct / operate belay system
 - Construct / descend / ascend a fixed rope system
 - Self-rescue
 - Construct / operate lowering system
 - Construct / operate a mechanical advantage system
 - Patient Packaging.



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NFPA 1983
Standard On Life Safety Rope and
Equipment For Emergency Services

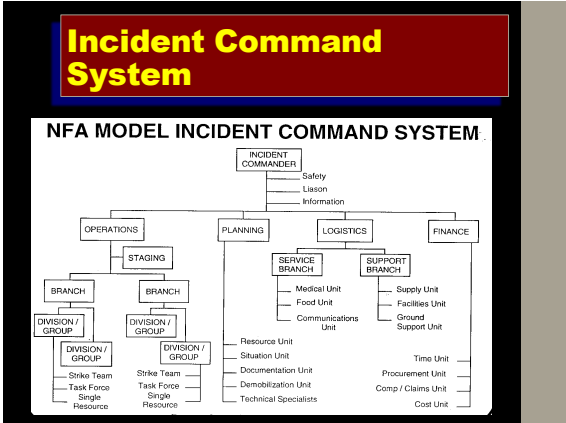
- **Certification**
- **Product Labeling and Information**
- **Design and Construction Requirements**
- **Performance Requirements**
- **Testing Requirements**
- **Does Not Cover**
 - Utility rope
 - Rope and equipment for special rescue operations (i.e. lead climbing)



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-
- Rescue ICS**
- **Common Terminology**
 - **Integrated Communications**
 - **Unified Command**
 - **Manageable Span of Control**
 - **Consolidated Plan of Action**
 - **Pre-designated Incident Facilities**
 - **Modular Organization**
 - **Comprehensive Resource Management.**

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Technical Rescue Operations

- Preparation
- Initial Response
- Assessment and Planning
- Incident Action Plan (IAP)
- Gaining Access
- Disentanglement
- Victim Package and Removal
- Incident Termination.



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ICS = Scalable



Initial Response


```

graph TD
  IC[Incident Commander] --> OTRO[Ops/TRO (Safety)]
  OTRO --> ML[Main Line]
  OTRO --> B[Belay]
  OTRO --> E[Edgeman]
  OTRO --> H[Haulers]
  OTRO --> M[Medic]
  OTRO --> A[Attendant]
  
```



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ICS = Scalable



Full Command Structure

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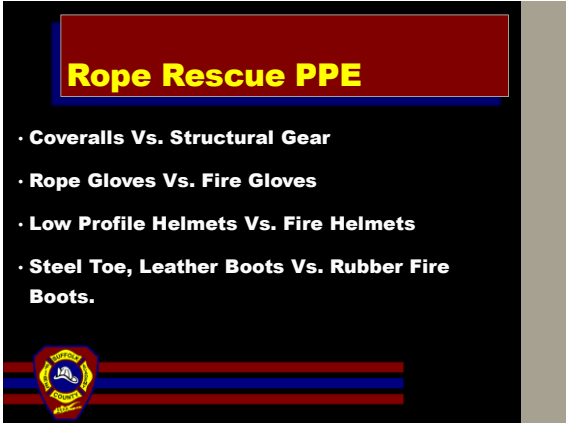
graph TD
  IC[Incident Commander] --> S[Safety]
  IC --> PIO[PIO]
  IC --> L[Liaison]
  IC --> O[Operations]
  O --> TRO[TRO]
  O --> EMS[EMS Ops]
  TRO --> ML[Main Line]
  TRO --> BL[Belay Line]
  TRO --> ST[Staging]
  TRO --> ED[Edge]
  TRO --> HA[Haulers]
  EMS --> ATT[Attendant]
  EMS --> MED[Medic]
  
```



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Life Safety Harness


- **Class I**
 - Fastens around waist, thighs, **OR** under buttocks
 - Designed for emergency escape with **one-person load**
- **Class II**
 - Fastens around waist, thighs, **AND** under buttocks
 - Designed for rescue where two-person loads can be encountered.



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Life Safety Harness

- **Class III**
 - Fastens around waist, thighs, and under buttocks and over shoulders.
 - Designed for rescue where two-person loads can be encountered, and inverting might be necessary
 - **What we use for technical rescue.**



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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.**



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Equipment and Hardware

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



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Rope Rescue Systems - Anchoring




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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!



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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.



26

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.**



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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.



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**Proper Anchors
Structural Steel**


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



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**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).



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Proper Anchors Motor Vehicles

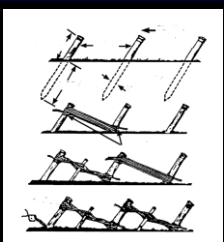
- Set Parking Brake
- Chock Front And Rear Wheels
- Transmission
 - Automatic = Park Manual = Reverse
- Remove Keys / Emergency Vehicle With No Keys Having Master Switch = Lights And Siren In On Position
- Anchor To Structural Parts of Vehicle / No Sharp Edges, Grease, Oil, Etc.



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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.



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Improper Anchors

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



KNOW YOUR ANCHORS!



33

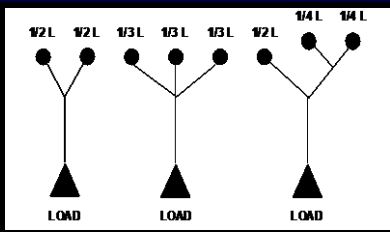
Directionals

- 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.



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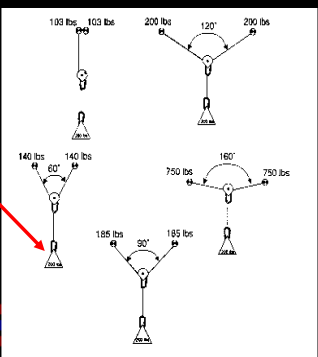
Variations In Anchor Point Loads



35

Critical Forces

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

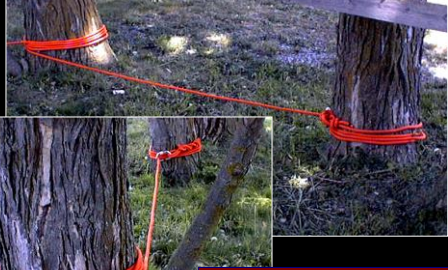


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Tensionless Hitch



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Tensionless Hitch With Backup



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Single Point Anchor (2 Looped Webs)



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Single Point Anchor Looped & Double Into Endless Sling



40

Single Point Anchor Backed Up Front To Back



41

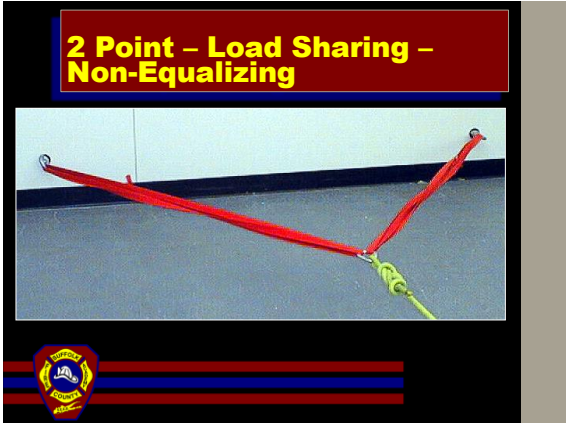
Single Point Anchor Backed Up With Tensioned Prusik



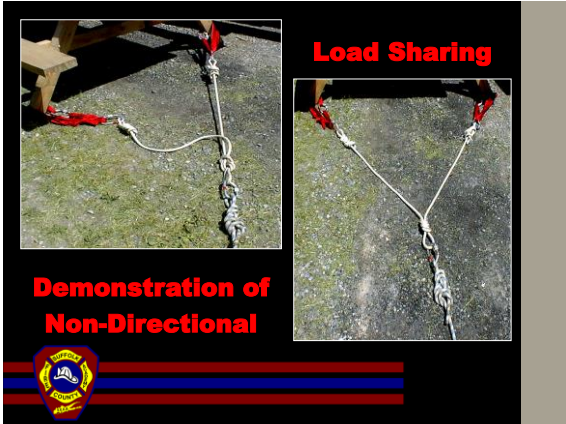
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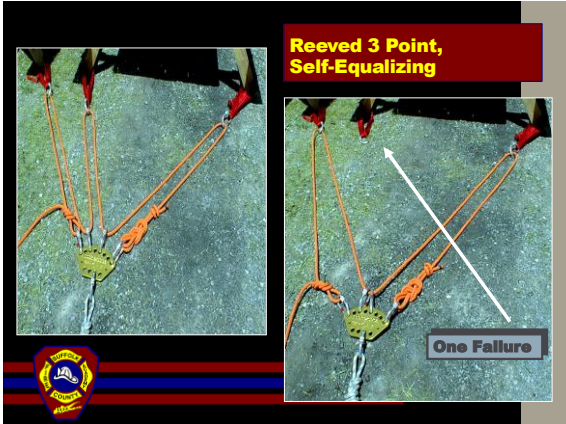
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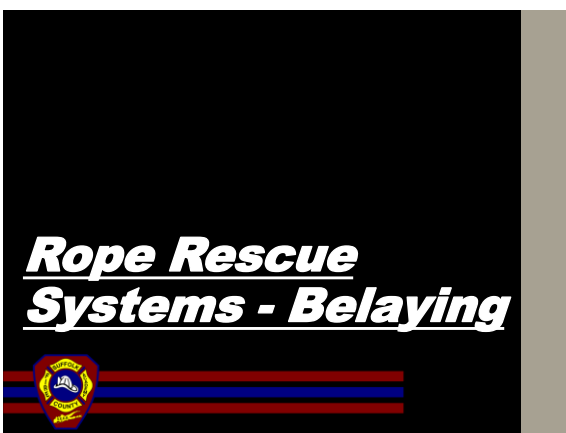
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50



51

Munter Hitch

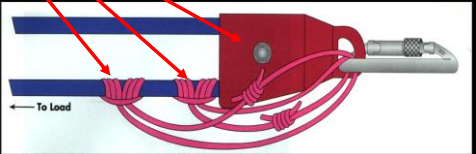
- Operated On Safety or Belay
- Used To Catch Falling Load OR Main Line Failure
- Do Not Pull Line Through Hitch, Feed It Through - Keep Hitch Loose
- Consider The Use of Shock Absorber At Point of Attachment To Load
- Use Large OR X-large Carabiner
- **NO MORE THAN 18" SLACK IN BELAY LINE**
- **SINGLE PERSON LOAD USE ONLY.**




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Tandem Prusik Belay (Safety) w/ Prusik Minding Pulley

- Operated On Safety / Belay Line
- Rated For **TWO PERSON LOAD**
- Components Include an 8' and 5' 8 MM Prusik Cord with Triple Fisherman's
- Prusik Minding Pulley
- Long, Short, Pulley.



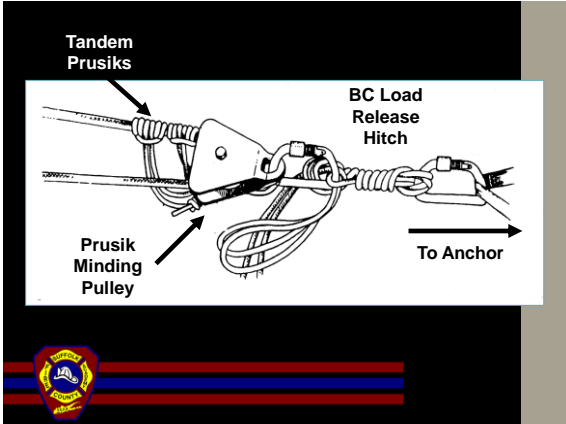
53

Mariners Hitch

- Used On Safety / Belay Line
- Used To Transfer Load From Safety / Belay Line In Event of Main Line Failure.




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Rope Rescue Systems – Mechanical Advantage Systems



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Mechanical Advantage


- Is Used To Move People or Equipment
- It Can Move A Load In All Directions
 - Up
 - Down
 - Horizontal.



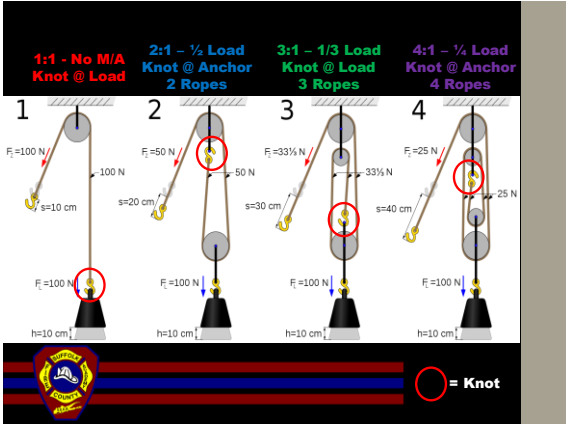

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Mechanical Advantage Rules

- The Higher The Advantage, The More Rope To Move
3:1 = 3' of Rope For 1' of Lift
- The Number of Ropes At The Load = The Amount of Mechanical Advantage
- Odd Systems (I.e. 3:1)
The Knot Is Toward The Load
- Even Systems (I.e. 4:1)
The Knot Is Toward The Anchor



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Pulley Configuration

- **Fixed Pulley**
 - **Called COD's**
 - **Provide no mechanical advantage**
- **Moving Pulley**
 - **Rigged to load**
 - **Move when load is pulled, hauled, raised.**

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Mechanical Advantage Equipment

- **Site Constructed Equipment**
 - **Standard rope rescue equipment**
- **Manufactured Systems**
 - **Power winch (Never use)**
 - **Tripod winch**
 - **Tube winch**
 - **Rope systems**

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Types of Mechanical Advantages

- **Simple**
 - **One rope on continuous tension**
- **Compound**
 - **2 or more systems attached**
- **Complex**
 - **Specialized systems.**



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Simple Mechanical Advantage Systems

- **Definition:**
 - **A form of mechanical advantage calculated by adding the total number of lines attached to (leaving) the load.**
- **Positive** = Reduces Amount of Energy Required To Move An Object
 - **400 lbs. = 100 lbs. (4:1)**
- **Negative** = Increases The Amount of Rope To Complete The System
 - **400' of rope = 100' of rope (4:1).**



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Simple Mechanical Advantage


- **Used On Short Hauls**
- **Can Only Be Used In A Straight Haul**
- **Simplest – Usually Carried Pre-Rigged**
- **A Component of A Compound System.**



66

Compound System

- Multiple Systems To Find M/A
- Can Attach Directly To Lowering Systems
- Can Go A Great Depth
- Can Make Changes In Direction.

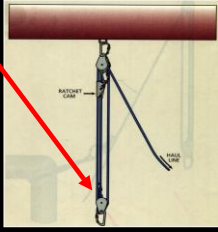


The diagram shows a compound pulley system. It consists of two 2:1 pulley blocks. The top block is fixed to a support, and the bottom block is attached to a load labeled 'LOAD'. The rope is anchored to the bottom block, passes up through the top block, down through the bottom block, up through the top block, and finally down through the bottom block. Labels '2:1' are placed next to each pulley block.

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3:1 Mechanical Advantage

- Knot To Load = Odd System, 3:1
- 100' Distance = 300' Rope
- 100 lbs. Load = 33 lbs. of Energy To Move
- AKA: Z-Rig.

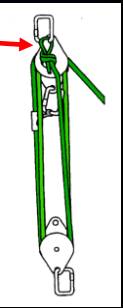


The diagram shows a 3:1 mechanical advantage pulley system. A rope is anchored to a fixed point (labeled 'ANCHOR'), passes down through a pulley attached to the load (labeled 'LOAD'), up through a fixed pulley (labeled 'MATCHSET CABLE'), and down through the load pulley. A red arrow points from the text 'Knot To Load = Odd System, 3:1' to the knot at the anchor.

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4:1 Mechanical Advantage

- Knot To Anchor = Even System, 4:1
- 100' Distance = 400' Rope
- 100 lbs. Load = 25 lbs. of Energy To Move.

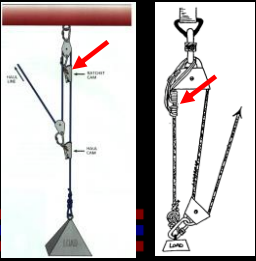



The diagram shows a 4:1 mechanical advantage pulley system. A rope is anchored to a fixed point (labeled 'ANCHOR'), passes up through a pulley attached to the load (labeled 'LOAD'), down through a fixed pulley, up through the load pulley, down through the fixed pulley, and up through the load pulley. A red arrow points from the text 'Knot To Anchor = Even System, 4:1' to the knot at the anchor.

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Progress Capture

- Used To Reset System
- Can Be Placed In Multiple Locations Within The System
- Can Use:
 - Rescue "8"
 - Gibbs
 - Prusik

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When Setting Up Your Mechanical Advantage System Be Sure To Take Into Consideration The Direction of Pull (Away From Edge) And The Amount of Space You Will Need To Haul.




71


Rope Rescue Systems – Lowering / Hauling



72

General Rigging Precautions

- Pad All Abrasion Points and Sharp Edges – Inspect Frequently
- Keep Components To Minimum (KISS)
- Avoid Non-Flexible Links (Hard Links)
- Check System Throughout Operation
- Avoid Nylon To Nylon In Rigging.




73

Lowering With Rack



74

Lowering With Figure 8



75

Lowering With MPD



76

Lowering With Petzel ID

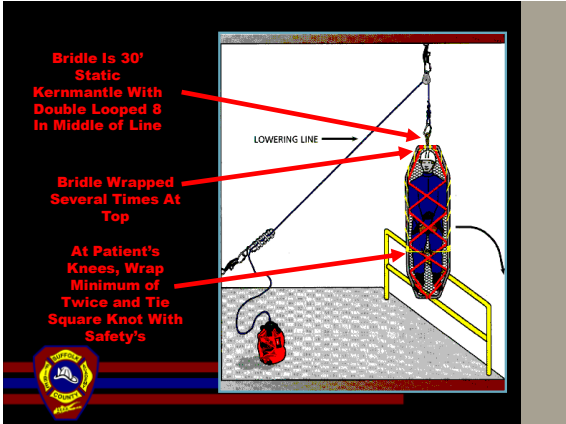


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Vertical Lower

- Patient Properly Secured To Backboard and Stokes/SKED
- 30' of 3/8" Rope Used As Bridle (SKED) - 1/2" For Stokes
- 1/2" Lower Line Connected To Bridle (Main)
- Safety/Belay Line Connected To Bridle
- Lowering of Victim Via Rack On Main.

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Horizontal Lower

- **“Brake Person”** Calculates Slack (Approx. 1”) for Plum Point
 - *Bridle will add approximately 1' - 2' to length of lower line*
- **Strong Hand On Inside Rail, Weak Hand On Outside Rail. All Crew Members, Same Hand On Same Rail**
- **Head Person Gives Command To Lower Over Edge.**

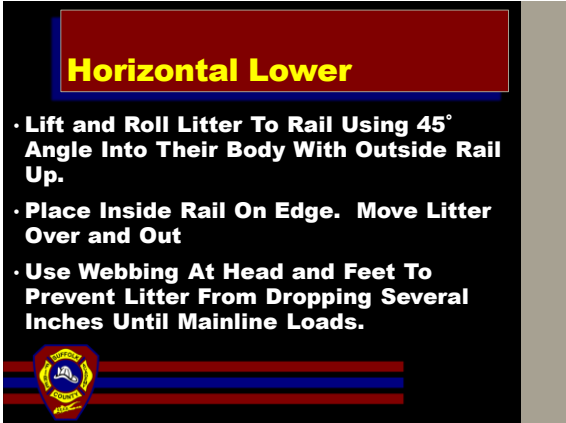
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Plum Point

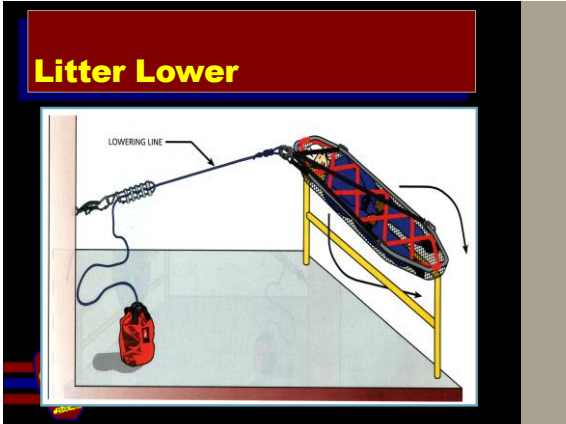
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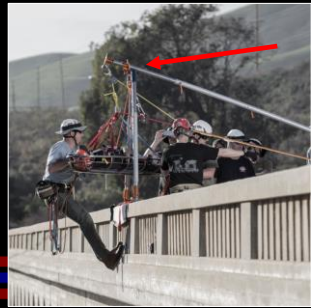
High-Points

- **Whenever Possible, Establish A High-Point To Allow For Easier Edge Negotiation**
- **If A High-Point Cannot Be Secured, A Vertical Lower Allows For Easier Edge Negotiation**
- **Tag-lines Should Always Be Attached Prior To Lowering The Victim In Either Configuration (Without An Attendant).**



85

High-Point Artificial



86

High-Point Upper Level



87

No High-Point Vertical Lower

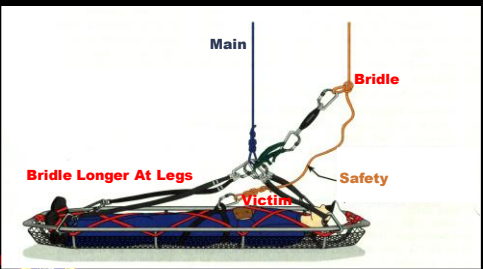
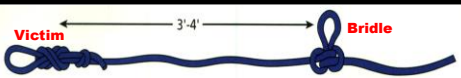


88

Tag Lines



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Hauling System
Z-Rig On Main Line

Object, Pulley 1, Pulley 2, Prusik 1, Prusik 2, Fixed Object (tree), Pull here

Identify The Parts

What Is The M/A of This System?

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Hauling System
Z-Rig On Main Line

Can Be A Rope Grab (Gibbs), Prusik Progress Capture

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Hauling System
Z-Rig On Main

MPD Progress Capture

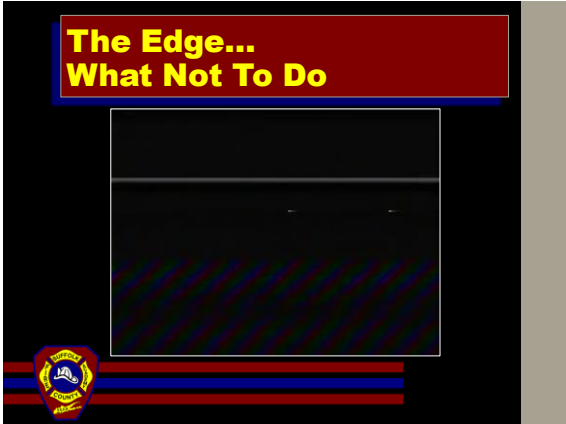
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96

Patient Packaging



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Stokes Basket

- **Steel/Titanium 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.**






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Patient Packaging

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



99

Diamond Lashing



- 30' 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.




100

Horizontal With Attendant

- Used To Navigate Obstructions
- Attendant Should Be Positioned To Provide Care to Victim And Manipulate Basket
- Attached To Main Line Via:
 - Pick-off strap
 - Adjustable anchor strap
 - Other adjustable device

101

Horizontal With Attendant

Safety Attachment:

- B**ridal
- V**ictim
- M**ember




102

Vertical With Attendant

- Used To Navigate Obstructions
- Attendant Should Be Positioned To Provide Care to Victim And Manipulate Basket
- Attached To Main Line Via:
 - Pick-off strap
 - Adjustable anchor strap
 - Other adjustable device




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Vertical With Attendant


Safety Attachment:

- B**ridal
- V**ictim
- M**ember




104


Questions?



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Hands-On Stations

- Anchoring and Belaying
- Mechanical Advantage
- Patient Packaging
- Horizontal Lower and Haul
- Vertical Lower and Haul.



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