

## **Basic Rigging for Rope Rescue**

**Objective:** Identify high and low angle rope rescue principles

### **Overview**

- **Current standards**
- **Tactical considerations**
- **Technical rescue equipment**
- **Rescue knots**
- **Anchor systems**
- **Belay systems**
- **Low angle rescues**
- **High angle rescues**
- **MA systems**
- **High lines**
- **Safety**

### **Current Standards**

- **NFPA 1006, 2007 Edition**

**NFPA 1983, 2006 Edition**

**NFPA 1670, 2004 Edition**

### **Tactical considerations**

- **4 phases**
  - Assessment on arrival
  - Pre-rescue operations
  - Rescue operations
  - Termination

#### **Phase I:**

##### **Assessment on arrival**

- **Primary assessment**
- **Secondary assessment**

#### **Phase II:**

##### **Pre-rescue Operations**

- **Incident action plan**
- **Gather resources**
- **Prepare the scene**
- **Set up communications**
- **Assemble rescue team**

#### **Phase III:**

##### **Rescue Operations**

- **Personnel accountability system**
- **Reaching victims**
- **Stabilization/Treatment**
- **Packaging victims**
- **Raising/Lowering victims**

#### **Phase IV: Termination**

- **Equipment retrieval**
- **Investigation**
- **Release of control**
- **Critical Incident Stress**

## **Debriefing (CISD)**

### **Interim Summary**

- **Current standards**
- **Four phases of technical rope operations**

### **Technical Rescue Rope**

- **Life safety rope**
  - Class one or two person
  - 15:1 Safety factor
- **Personal escape rope**
  - One-person, one-time use only
  - 10:1 Safety factor

### **Rope Construction**

- **Kernmantle**
  - Kern (core)
  - Mantle (sheath)
- **Two types**
  - Static
  - Dynamic

### **Rope Records**

- **NFPA 1500 requires all life safety ropes to have a record**
- **Rope log should annotate:**
  - Use
  - Inspections
  - Damage

### **Rope Inspection**

- **Use manufacturer's recommendation**
- **Visual and manual inspection**
- **Inspect new ropes as well**
- **Retire when necessary**

### **Interim Summary**

- **Life safety rope**
- **Personal escape rope**
- **Rope construction**
- **Rope records**
- **Rope inspection**
- **Rope care**

### **Auxiliary Equipment**

- **Personal use**
- **General use**

### **General Use Auxiliary Equipment**

- **Minimum tensile strength**
- **Anchor straps 10,120 (45 kN)**
- **Rope 8,992 (40 kN)**
- **Carabiners 8,992 (40 kN)**
- **Pulleys 8,093 (36 kN)**
- **Portable anchor devices 8,093 (36 kN)**
- **Manufactured systems 8,093 (36 kN)**
- **Pickoff straps 6,070 (27 kN)**

- Decent control device 4,946 (22 kN)
- Rope grab device 2,473 (11 kN)

#### Ascenders

- Gibbs
- Petz
- Prusiks

#### Ascenders

- Minimum of two ascenders required
- Common equipment failures:
  - Frame breakage
  - Rope damage
  - Rope slipping out of ascender

#### Carabiners

- Oval or D-shaped metal, load-bearing connector with a self-closing gate, used to join other components of a rope system
  - Locking steel are most common
  - If one constantly comes unlocked, toss it

#### Carabiners

- Terminology

#### Carabiners

- Personal Use
  - Stamped "P"
- Strength
  - Gate closed: 6,069 lbf
  - Gate open: 1574 lbf
- General Use
  - Stamped "G"
- Strength
  - Gate closed: 8992 lbf
  - Gate open: 2,473 lbf

#### Descent Control Devices

- Personal Use
- Strength
  - 3,034 lbf without failure
  - 1200 lbf without permanent damage to the device or rope
- General Use
- Strength
  - 4,946 lbf without failure
  - 1200 lbf without permanent damage to the device or rope

#### Descent Control Devices

- Brake bar rack

#### Descent Control Devices

- Figure eight

#### Edge Protection

- Abrasion
  - one of rope's worst enemies
- Edge rollers reduce friction and stop abrasions
- Rope pads useful for stationary rope

- **Use whatever is available in a pinch**

#### **Other auxiliary equipment**

#### **Hardware Construction**

- **Aluminum**
  - High strength and light weight
  - Less expensive
  - Poor abrasion and wear qualities
- **Steel**
  - Stronger
  - Resists wear and abrasion
  - Holds up better in shock load situations
  - Preferred for rescue

#### **Auxiliary Equipment**

- **Nylon webbing**
  - Either flat or tubular design
  - Sizes range from 1/2 in. to 3 in.
  - Used for anchors, patient packaging, self rescue harness slings
  - Anchor straps, pick-off straps, etc.

#### **Auxiliary Equipment**

- **Personal protective equipment**
  - Life safety harness
  - Gloves
  - Helmet
  - Boots

#### **Auxiliary Equipment**

- **Class I** – fastens around waist & thighs or under buttocks, designed for emergency escape with one-person loads

#### **Auxiliary Equipment**

- **Class II** – fastens around waist & thighs or under buttocks, designed for rescue where two-person loads can be encountered

#### **Auxiliary Equipment**

#### **Interim Summary**

- **Personal/General**
- **Hardware inspection**
- **Ascenders**
- **Carabiners**
- **Descenders**
- **Edge protection**
- **Hardware construction**
- **Webbing**

#### **Fall Factors**

- **Distance of fall divided by amount of rope between person and anchor or belay**

#### **Knots**

- The ability to tie knots correctly, confidently, without hesitation, and know how they are used, are necessary skills for the high angle rescuer.
- **Characteristics of a good knot**
- **Knot terminology**

- **Overhand**
- **Figure 8**
- **Figure 8 on a bight**
- **Figure 8 follow through loop**
- **Double loop figure 8**
- **Inline figure 8**
- **Butterfly knot**
- **Clove hitch**
- **Munter hitch**
- **Water knot**
- **Double fisherman (grapevine) knot**
- **Prusik hitch**
- **We will use the triple wrap for all operations**

#### **Interim Summary**

- **Fall factors**
- **Knots**
  - Characteristics
  - Terminology
  - Uses

#### **Anchor Point Selection**

- **Natural**
- **Manmade**
- **Vehicles**

#### **Anchor Point Selection**

- **Multiple anchor points should be selected**
- **Bombproof when possible**
- **Anchor points are often the weakest link in any system**
- **Common reasons for anchor failure**
  - Inadequate strength
  - Incorrectly tied knots
  - Carabiners unlocked
  - Abrasion of software
  - Stress on hardware

#### **Anchor Points**

- **Single point anchors**
- **Tensionless hitch**
- **Single point**
- **Figure eight follow through**
- **Single point - Wrap 3 Pull 2**
- **Multi-point**
- **Load sharing**
- **Look at the tri loaded carabiner great place for a delta (triangle screw link)**
- **Multi-point**
- **Load distributing**
- **Critical angles**
  - The angle formed in the webbing or rope used to join the anchors
  - 120 degrees is the critical angle because each leg is holding 100% of the load
- **Re-directs**

- Change the direction of the load
- The greater the angle of the re-direct, the less the force exerted on it
- Should be kept **over** 120 degrees
- Never **less than** 90 degrees
- You can put double the force on the re-direct (becomes a 2 to 1 MA)

➤ **Anchors**

- Factors for the angle formed by the legs of the anchor in a two point anchor system
- 180 degrees = 12
- 150 degrees = 1.94
- 120 degrees = 1
- 90 degrees = 0.71
- 60 degrees = 0.58
- 30 degrees = 0.52

**Re-direct**

- Factors for the angle of the re-direct
- 150 degrees = 0.52
- 120 degrees = 1
- 90 degrees = 1.4
- 60 degrees = 1.73
- 0 degrees = 2

**Anchors**

- **Anchor rigging principles**
- Back up all questionable anchor points
- Pad any abrasion points
- Keep the components to a minimum (KISS Principle)

**Interim Summary**

- **Anchor point selection**
- **Reasons for anchor failure**
- **Single point anchors**
- **Multiple point anchors**
- **Critical angles**
- **Re-directs**
- **Anchor rigging principles**

**Belay Systems**

- **Definition**
- **Used whenever the potential for a fall exists**
- **Communications**
  - Speak loudly!
  - “On belay... Belay on”
  - “Off belay... Belay off”
  - “STOP”
  - System activation

**Belay Systems**

- **Safety**

- Belay always set up first on best anchor
- Use a separate anchor point
- Gloves
- Fall protection
- Communication
- Constant attention of belayer

### **Belay Systems**

#### ➤ **Types of Belays**

- Personal belay devices

### **Belay Systems**

#### ➤ **Bottom belay**

- Belay is below load
- Pulling on the rope increases friction on descender
- Used for rappels only
- Doesn't protect catastrophic failure

### **Belay Systems**

#### ➤ **Self belay**

- Prevents free fall if rappeller loses control of the rope
- Natural reactions may defeat the device

### **Belay Systems**

#### ➤ **Munter hitch**

- Binds on itself to stop a fall
- Belayer holds the rope firmly with the brake hand
- Only used with one person loads

### **Belay Systems**

#### ➤ **Tandem prusik belay**

### **Belay Systems**

#### ➤ **Belay rigging principles**

### **Interim Summary**

- **Belay uses**
- **Belay communications**
- **Safety during belay operations**
- **Types of belays**
- **Belay rigging principles**

### **Low Angle Rescues**

- **One of the most common rescues**
- **Used to move a litter over difficult terrain**
- **Main risk to rescuers is broken ground and steep/difficult terrain**

### **Low Angle Rescues**

- **Characteristics of slope evacuation**
- **Elements needed**
- **Packaging victims**

### **Low Angle Rescues**

- **Immobilize potential spinal injuries**
- **Two litter types**
- **Litter operations require two things:**
- **Considerations**

### **Low Angle Rescues**

- **Litter tender tie-ins**
- Multi-loop strap

#### **Low Angle Rescues**

- **Litter tender tie-ins**
- Webbing loop

#### **Low Angle Rescues**

- **Litter tender tie-ins**
- Cord loop

#### **Low Angle Rescues**

- **Litter tender tie-ins**
- Adjustable

#### **Low Angle Rescues**

- **Communications**
  - Litter captain gives all commands
  - To raise litter: "one, two, three, lift"
  - Once everyone's ready: "pre-load"
  - Once everyone's ready again: "down slow, or up slow"
  - Anyone can call "stop" at any time