The following power point training presentations must be viewed at unit training and/or under the supervision of an OSRT Officer.

Members viewing the presentations must sign a OSRT sign in sheet. The completed sign in sheet must be submitted to the OSRT Planning (Training) Section to receive credit for the training.

Rope Rescue

Presented by

WPAFB FD

Reference

- ASTM 2751, Para 5.3.2-5.3.6; 6.4-6.7
- ASTM 2890, Para 1.2.4

Training power point slide program prepared by
Headquarters OSRT- 28 Jan 15;
Revised 23 Oct 2015

Objectives

- Demonstrate the following:
  - Knowledge of rope types & strengths
  - Tying basic knots
  - Knowledge of rope software & hardware
  - Knowledge and use of anchoring points
  - Constructing mechanical advantage systems
  - Basket operations

References

- NFPA 1983, Standard on Fire Service Life Safety Rope and System Components, 2001 Edition
- Rescue Technician Instructor Guide, Department of Defense Fire Academy
- Fire Service Rescue, Sixth Edition, IFSTA
- NFPA 1670, Standard on Operations and Training for Technical Rescue Incidents, 1999 ed.
- NFPA 1006, Standard for Rescue Technician Professional Qualifications, 2001 ed.
- PHTLS, Mosby, Fourth Edition

Ropes Used In Rescue

- Static Kern mantle
  - Fiber bundles run parallel
  - Stretches no more than 20%
  - Known as “low-stretch rope”
- Dynamic Kern mantle
  - Made of twisted strands
  - Stretches as much as 60%
  - Known as “high-stretch rope”

Strengths for Lifeline Rope

- Tensile or Breaking Strength
  - 7/16” – 6,000 lbs
  - 1/2” – 9,000 lbs
  - 5/8” – 13,000 lbs
- Working Strength = Tensile / 15

NFPA Rope Classifications

- Class 1 (Light use) – One person life safety rope w/ > 300 lbs working strength
- Class 2 (General use) – Two person life safety rope w/ > 600 lbs working strength
- Note: Life Safety Rope must have an internal tracer tape indicating compliance

Inspection and Care

- Use manufacturer's recommendations
- Inspect by looking and feeling
- New ropes inspected and a rope log created
- Rope should be retired based on experience and good judgment, used in conjunction with education
- Store IAW manufacturer’s recommendations and to avoid degradation from the environment
  - sun, heat, exhaust, acid, hot concrete
- Rope can be washed by hand with a commercial rope washer or in a laundry machine

Basic Rescue Knots

- Overhand Safety Knot
  - Used with all other knots
- Water Knot
  - Used to join two ends of webbing
- Bowline
  - Used as a Rescue Knot or to hoist tools

Basic Rescue Knots

- Clove Hitch
  - Used secure a rope to an object
    - Around an object
    - Over an object

- Double Fisherman
  - Used to create a prussic hitch

Basic Rescue Knots

- Figure Eight Knot
  - On a bight – around an object
  - Follow through – around an object
  - Double loop – for a dual anchor point
  - Inline – as a anchor point

Basic Rescue knots

Grog's Search & Rescue Knots

WWW.ANIMATEDKNOTS.COM

Associated Software & Hardware

- Webbing
  - Flat or Tubular
  - Used in place of or with rope
  - Strength
    - 1” = 4,500 lbs tensile
    - 2” = 6,000 lbs tensile

Associated Software & Hardware

- Harnesses
  - Constructed of sewn webbing
  - Types:
    - NFPA/ANSI Class I – seat style for emergency escape
    - NFPA Class II/ANSI Class IV – seat-style for rescue
    - NFPA/ANSI Class III – full body
  - Note: Only full body harnesses should be used when there is any likelihood that the rescuer will be turned upside down

Associated Software & Hardware

- Carabiners
  - Constructed of steel or aluminum
  - Used to connect rope/webbing to objects
  - Types & Strengths:
    - Steel – 6,700lbs tensile
    - Aluminum – 5,500 lbs tensile
- Figure Eights
  - Constructed of aluminum
  - Used for descent control
  - 20,000 lbs tensile

Associated Software & Hardware

- Ascenders
  - Constructed of aluminum
  - Used for descent control and climbing
  - 2,500 lbs tensile
- Pulleys
  - Constructed of aluminum
  - Used for mechanical advantage systems or change of directions
  - May be single or multi sheave

Associated Software & Hardware

- Prussic cords
  - Formed using 6 to 9mm kern mantle rope
  - Ends connect using a double fisherman knot
  - Used in place of an ascender
- Slings
  - Formed from nylon webbing w/ sewn in loops
  - Used to secure rope to an anchor point or object being moved

Anchor Points

- Selection
  - Fixed object (Railing or I beam)
  - Apparatus (Sturdy components)
  - “BFR” very big rock
  - Picket system (difficult)

  - Always have a second/separate anchor point for the backup line

Picket Anchor System

- Each point has an approx. rating of 350 lbs
- Lash from the top of the front picket to the bottom of the next one working backwards

Anchor Points

- Types:
  - Single point
    - Tensionless hitch
    - Wrap 3 - Pull 2
    - Figure eight follow through
    - Commercial straps
    - ***Never use a girth hitch***

Anchor points

- **Multiple points**

Load sharing

Load distributing

Anchor Point Critical Angles

- Any angle in an anchor system will increase the loading on anchors and other element of the system
- For safety, **90 degrees** is the maximum preferred angle, 120 degrees should **NEVER** be exceeded
- Factors for the angle formed by the legs of the anchor in a two point anchor system

30 degrees = 0.52
60 degrees = 0.58
90 degrees = 0.71
120 degrees = 1
150 degrees = 1.94
180 degrees = 12

Redirect Critical Angles

- The greater the angle of the re-direct, the less the force exerted on it
- Never <90 degrees
- Should be >120 degrees

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

Belays

Options

--Prusik

--Bar Rack

--540 Belay

(Two person)

--Figure 8

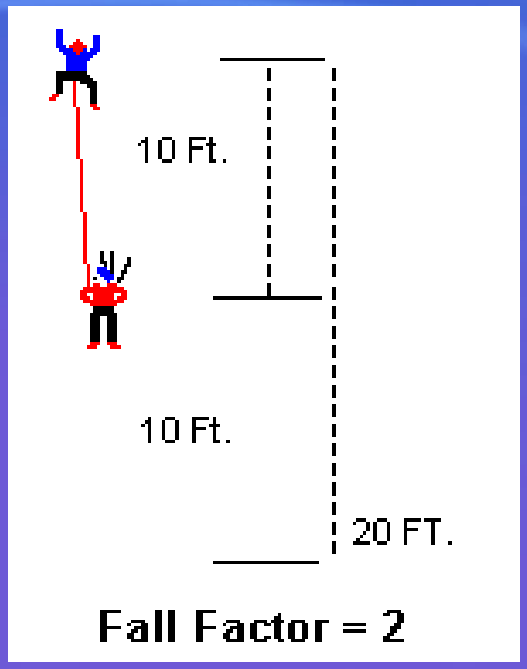
--Munter hitch

-- Gibbs

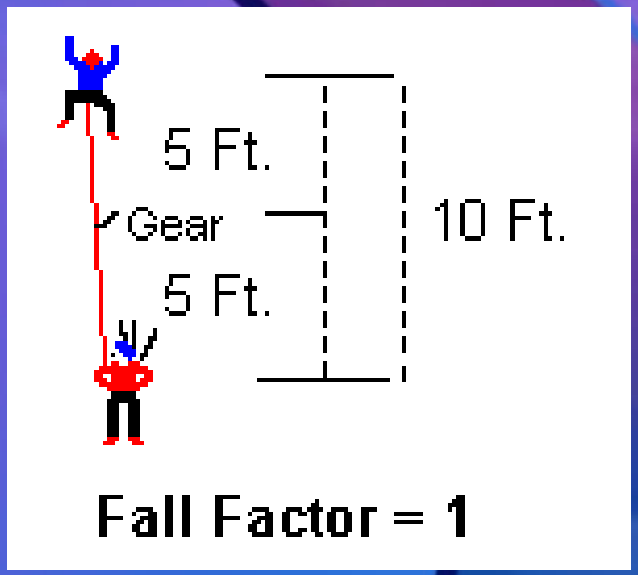
(One person)

Fall Factors

- Fall Factor = the distance fallen divided by the length of rope used to arrest the fall
  - A fall factor of .25 is preferred



Fall factor = 20 feet of fall / 10 feet of rope



Fall factor = 10 feet of fall / 10 feet of rope

Mechanical Advantage Systems

- Mechanical Advantage – the relationship between how much load can be moved, to the amount of force it takes to move it
  - Simple – 2-1, 3-1 (modified Z-rig), 4-1 (block & tackle), 5-1 (modified Z-rig)
  - Compound – using two simple systems together multiply the advantage (3-1 & 3-1 = 9-1)
- The two most used systems are the 3-1 (modified Z-rig) and the 4-1 (block & tackle)

Simple Haul Systems

- 2 to 1

Simple Haul Systems

- 3 to 1

Simple Haul Systems

- 4 to 1 block & tackle

Compound Haul Systems

- 6 to 1

Compound Haul Systems

- 9 to 1

Stokes Basket

Secure the victim with webbing harnesses

Lash the basket from the bottom to the top with webbing or rope

Basket Lowers

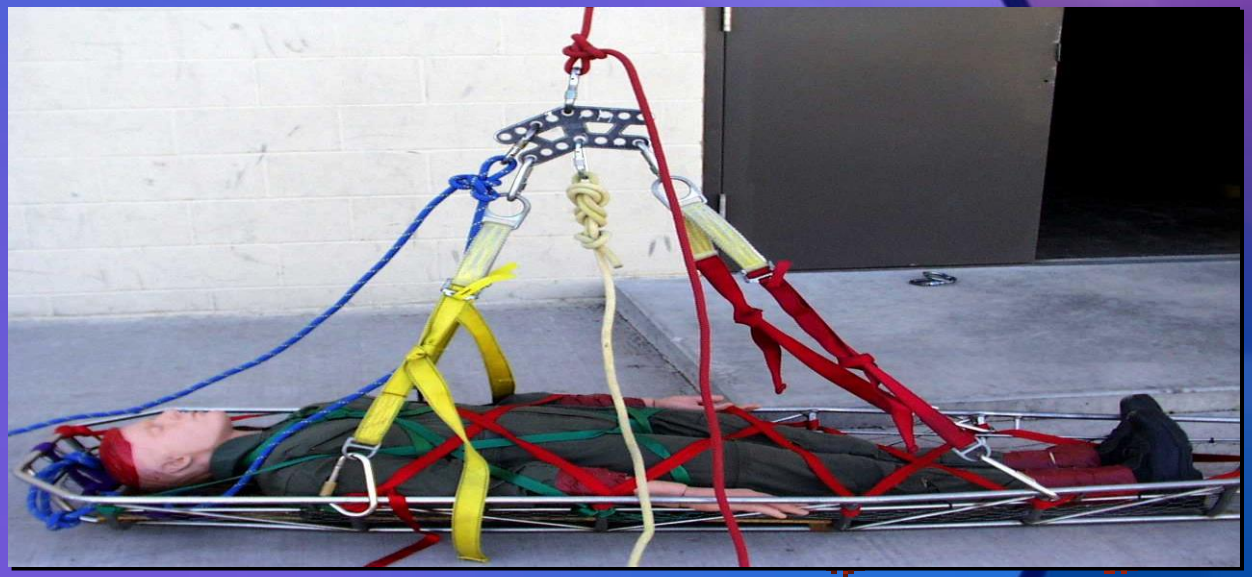
- Used when a victim is injured or unwilling to perform a pick-off
- Requires teamwork and practice
- Victim needs to be packaged
- Lowering device should be a “general use” brake bar rack for any two person load

Basket Lowers

- **Safety factors**
  - Higher weight loads and complexities
  - System safety checks
    - 3 person checks (1 being the Safety Officer)
  - More people involved
    - basket tenders, edge tenders, brake operators, belayer, team leader, haul captain, safety officer
- **Position of basket for lower**
  - Horizontal
  - Vertical

Basket Lowers

- **Single line lower with a belay**
  - One main line, one belay line for litter
  - One litter tender
  - Advantage: simpler rope work and brake management



Basket Lowers

- **Double line lower**
  - May simplify rigging
  - Makes using a second tender easier
  - Beneficial when it's necessary to negotiate litter through obstacles or confined spaces
  - Allows easy changeover from horizontal to vertical

Basket Lowers

- Attaching basket to litter
  - Two-point bridles

Basket Lowers

- Tag lines - preferred over tenders
  - To position litter in a confined space
  - Prevent snagging on overhangs
  - Holds litter away from the wall
  - Stops spinning in free-hanging operations
  - Helps get the litter over the edge

Patient Care - Trauma

Laws of Energy

- Newton's first law of motion – A body at rest will remain at rest and a body in motion will remain in motion unless acted upon by some outside force. Examples: the ground or gravity etc…

- Newton's law of conservation of energy – Energy cannot be created or destroyed but can be changed in form. Types of energy: mechanical, thermal, electrical & chemical. Examples: Transfer of energy during a car accident.

Patient Care - Trauma

Kinetic energy is a function of an objects weight/ mass and speed/velocity

KE=M/2 x V2

Examples: 150lbs @ 30 mph = 67,500 KE units
160lbs @ 30 mph = 72,000 KE units
150lbs @ 40 mph = 120,000 KE units

Velocity/speed increases the production of KE more then mass

Blunt Trauma injuries

- Two forces involved:
  - shear (tearing)
  - compression

Both result from one organ or object changing speed faster then another organ or object

Blunt Trauma injuries

- Body system injuries
  - Head
  - Neck
    - Direct in-line compression – crushes the vertebrae
    - Hyperextension – from neutral backwards
    - Hyperflexion – from neutral forwards
    - Lateral flexion – side to side
    - Rotation

Blunt Trauma injuries

- Body system injuries
  - Thorax – The sternum receives the initial energy exchange and the internal organs continue to move until they strike the inside of the chest cavity.
    - Aortic tear (partial or complete)
      - 80% die on scene
      - 1/3 of remaining 20 % die in either 6 hrs, 24 hrs or 72+ hrs
    - Pneumothorax (tension)
    - Flail chest – 2 or more broke ribs in 2 or more locations
    - Cardiac contusion
    - Lung contusion

Blunt Trauma injuries

- Body system injuries
  - Abdomen
  - Kidneys, spleen, small and large intestines
  - Liver - The Ligamentum Teres (remnant of the uterine vessels) attaches to the anterior abdominal wall at the umbilicus and to the left lobe of the liver
  - Pelvic injuries
  - Diaphragm

Falls

Height of fall (including the patients' height)

- Velocity increases with height

Landing surface

- Compressibility (ability to deform by energy transfer)

What hit first?

- Feet – Bilateral heel bone, ankle or distal Tabular/fibula fractures
- Legs - After the feet stop, the legs absorb the energy = knee, femur and hip fractures
- Spine – Flexion causes compression fractures to the thoracic and lumbar area from weight of head and torso
- Hands – bilateral wrist fractures
- Head (shallow diving injury) – All the weight from the moving torso, pelvis and legs are focused on the head and cervical spine, compressing and fracturing the c-spine.

Safety Essentials

- Personnel Protective Equipment
- Fall protection for all personnel working in elevated positions
- Redundancy
- Safety Checks
- Safety Officer

Practical Exercises

Station 1 - Knots and anchoring to objects

- Have each student tie the following knots with safety knot
  - Water knot
  - Bowline
  - Clove Hitch
  - Clove Hitch around an object
  - Clove hitch over an object
  - Split clove hitch
  - Figure Eight family
    - Figure Eight - on a bight
    - Figure Eight - follow through
    - Figure Eight - double loop
    - Figure Eight - inline
  - Double fisherman
- Have each student demonstrate the following methods of anchoring to an object
  - Single point with rope and webbing
  - Tensionless with rope
  - Multiple points
- *NOTE:* The knot tying and anchoring can be done in conjunction with one another.

Practical Exercises

Station 2 - Constructing mechanical advantage systems

- Divide the students into groups of no more than three or four and have each group demonstrate reeving each of the following using both prussic cords and ascenders
  - Z-rig
  - 4-1
- Have the students demonstrate using the Z-rig to move an object

Practical Exercises

Station 3 – Patient packaging

- Stokes Basket
  - Construct harness with webbing
  - Lash patient into basket
- Miller Half-back
  - Secure patient using all straps provided

Questions?