Department of Fire Services

Massachusetts Firefighting Academy
Technical Rescue Programs

ROPE RESCUE
TECHNICIAN LEVEL

STUDENT MANUAL

05.01.2015

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Levels of Operation

Awareness NFPA 1670 4.1.4(1)
This level represents the minimum capability of organizations that provide response to technical search and rescue operations.

Operations NFPA 1670 4.1.4(2)
This level represents that capability of organizations to respond to technical search and rescue incidents and to identify hazards, use equipment, and apply limited techniques specified in this standard to support and participate in technical search and rescue incidents.

Technician NFPA 1670 4.1.4(3)
This level represents the capability of organizations to respond to technical search and rescue incidents, to identify hazards, use equipment, and apply advanced techniques specified in this standard necessary to coordinate, perform and supervise technical search and rescue incidents.

Reasons For Failure of Technical Rescue Operations

Acronym: FAILURE

F – Failure to understand or underestimating the environment

A – Additional medical implications not considered

I – Inadequate rescue skills

L – Lack of teamwork and experience

U – Underestimating the logistical needs of the operation

R – Rescue versus recovery mode not being considered

E – Equipment not mastered

Size Up

- Distinction between rescue and recovery
- Scope and Magnitude
- Additional Resources
- Location and Number of Victims
- Risk Benefit Analysis
- Separation, isolation, interviewing, security of witnesses
- Hazards- utilities, mechanical, hazmat
- Access to Scene
- Environmental Factors

Incident Operation

Size-up

_____

Develop IAP

_____

Set-up

_____

_____

_____

_____

Consider next step

_____

Effect Rescue

_____

_____

_____

In any area of technical rescue the safety of the _____ comes first. Without this, the rescue itself might become impossible.

Two common causes of rope failure are:

1) _____

2) _____

Avoid introducing _____ into any system as this can lead to a _____ load.

ANCHORS

Anchor Point

- A single, structural component used either alone or in combination with other components to create an anchor system capable of sustaining the actual and potential load on the rope rescue system.

Anchor System

- One or more anchor points rigged in such a way as to provide a structurally significant connection point for rope rescue system components.

Anchors should be SeRENE!

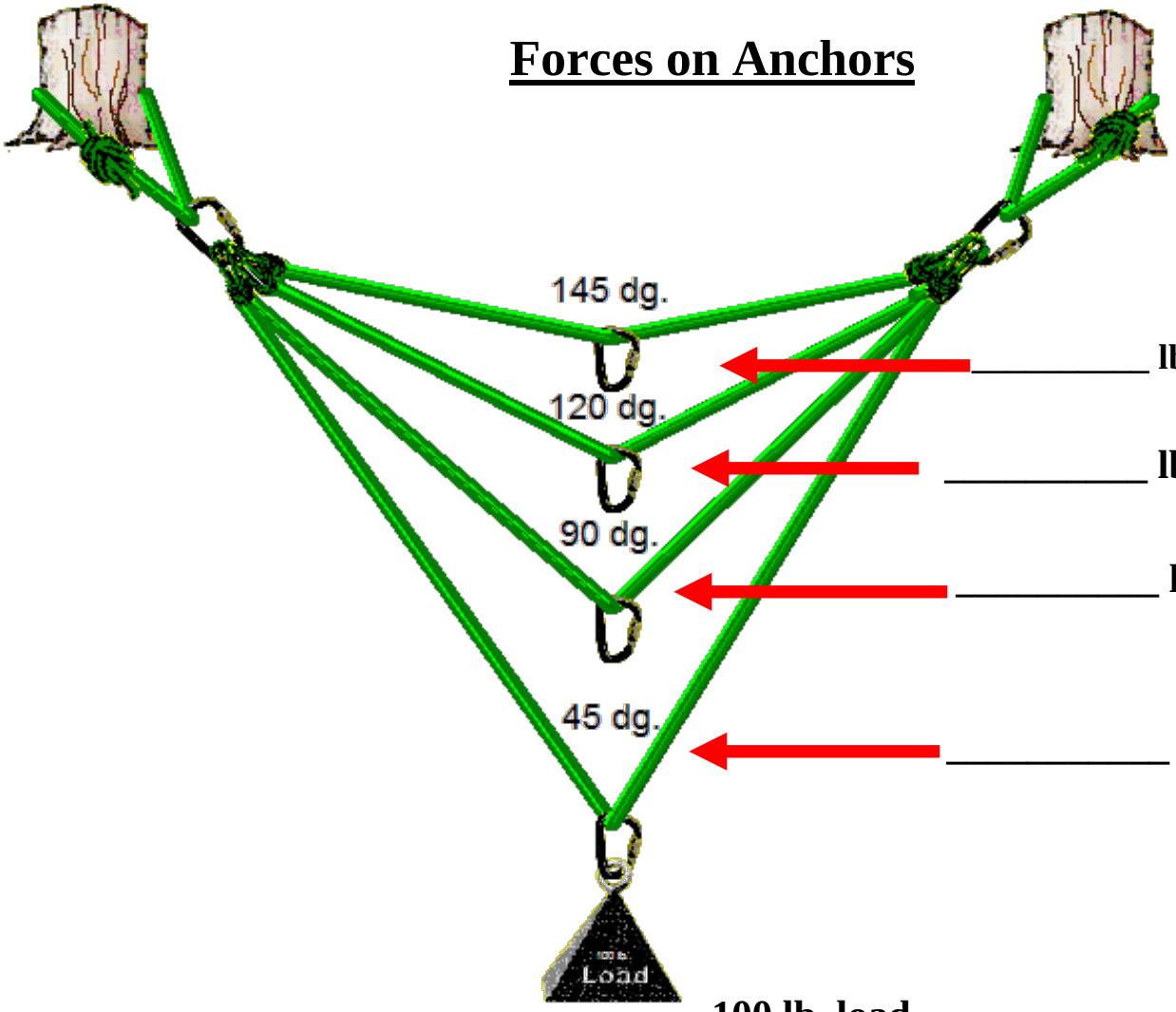
What does SeRENE stand for?

S - _____
e
R - _____

E - _____

NE - _____

Forces on Anchors



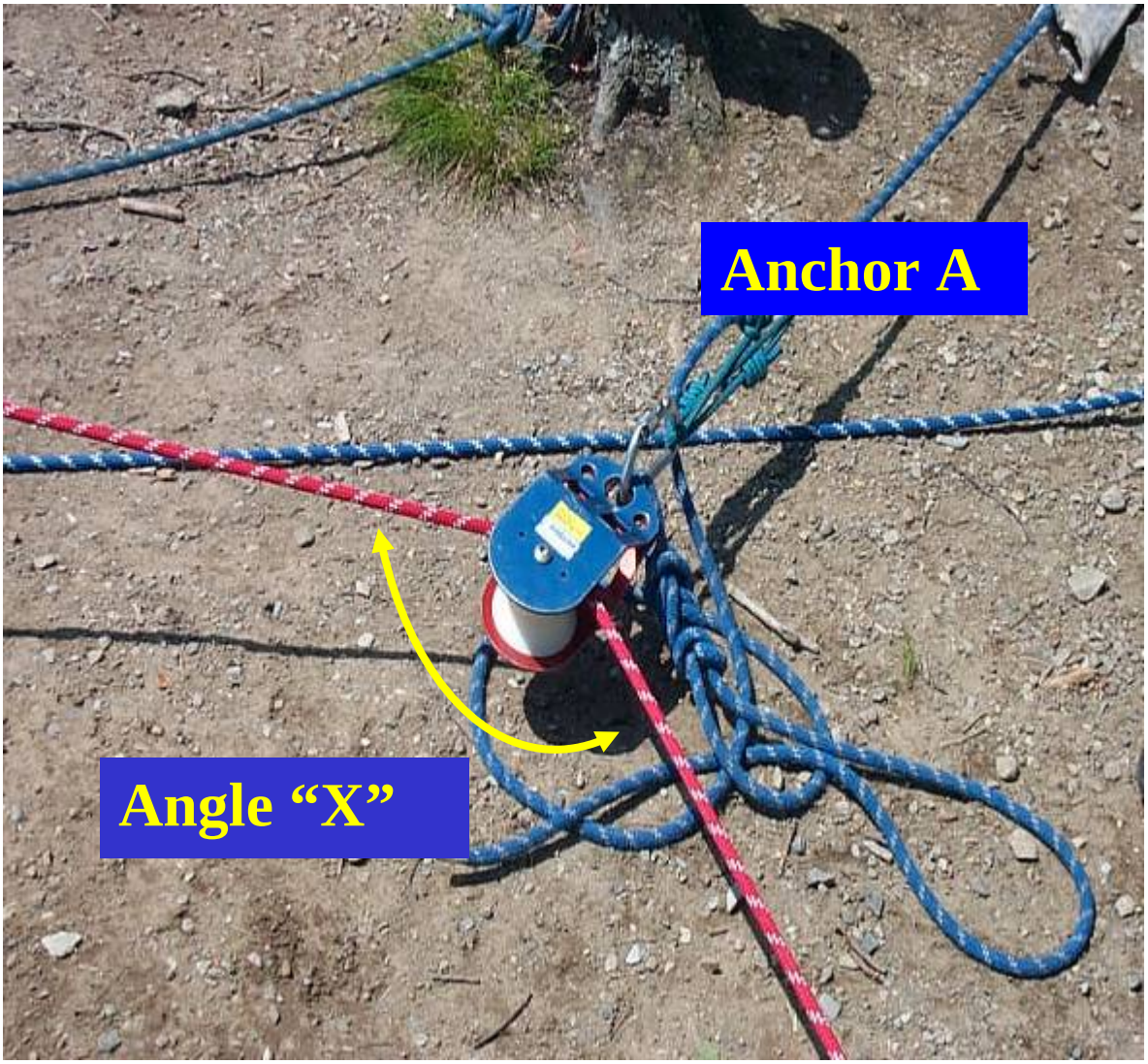
_____ lbs. each leg!

_____ lbs.

_____ lbs.

_____ lbs.

100 lb. load



Force on a directional pulley's anchor changes with the angle.
With a 200 pound load, force on the directional anchor increases at various angles.

X	A
180 degrees	0 pounds
160	69.5
120	200
90	282
10	398
0	400

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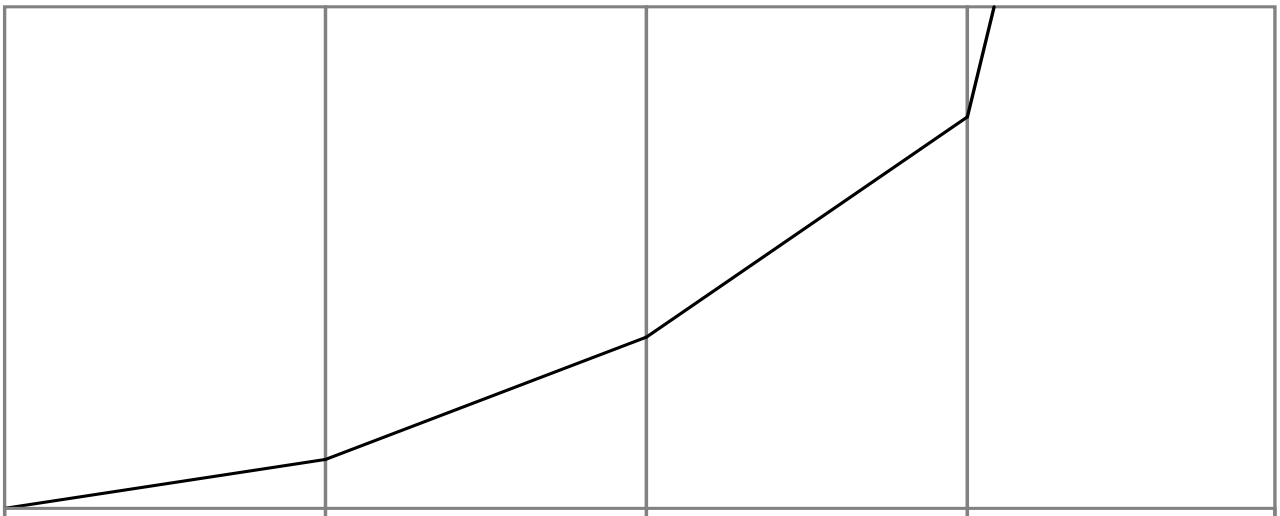
Rescue Angles



Degrees	0 - 15° Flat	15-40 ° Low Angle	40-60° Steep Angle	60-90° High Angle
Risk	Minimal	Low	Extreme	Less Extreme
# Ropes	0 - 1 rope	?	Two rope systems	

Mechanical Advantage

WEIGHT OF LOAD ⟷ FORCE NEEDED TO MOVE LOAD

100 LBS. : 100LBS.

MA IS 1:1

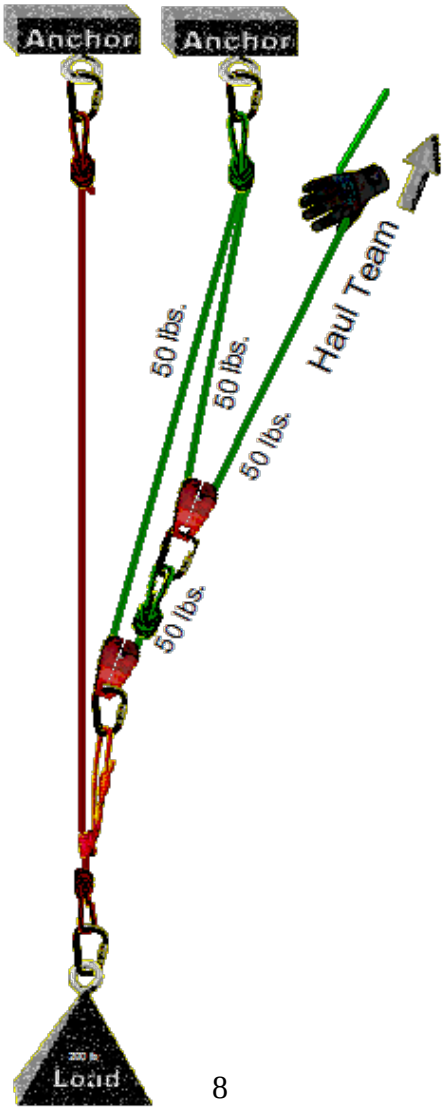
Load distributed over a greater surface area

SIMPLE SYSTEMS

- Advantage at end with Pulleys side by side
- You **add** to get the mechanical advantage
- Pulleys move at the same speed
- Moving pulleys – how many sections of rope supports the load

COMPOUND

- One single pulley system pulling another single pulley system
- Analyze at end with moving pulleys by **multiplying** the mechanical advantage of each simple system



COMPLEX

- Combination of **Simple** and **Compound** systems
- Pulleys move in different directions at different rates of speed
- Not commonly used by Fire Service or Rescue teams

A ___**_____**_ pulley gives no mechanical advantage and acts as a force multiplier as well as a change of direction.

A ___**_____**_ pulley provides mechanical advantage and travels.

SAFETY FOR HAUL SYSTEMS

- If any increase in resistance, haulers stop and call “stop”
- People powered systems and not mechanical systems
- Generally not more than 4:1 mechanical advantage
- Generally not more than 4 haulers

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Lead Climbing and Similar Skills

- Situations may require lead climbing or similar skills.
  - Necessary when victim is located above grade, without overhead anchors readily available.
  - Ie. Towers, bridges, smoke stacks, cliffs

- Involves climbing above fixed anchor system and setting provisional anchors every 3-5 feet attached to bottom belay.
  - Dynamic rope is used
  - Industrial settings for rescue
  - Rock climbing for recreation

Lead Climbing Equipment

- Various methods available
  - Traditional lead climbing
    - Using rope and setting anchors as you climb
  - Lanyards
    - Y Lanyards
    - Shepherds Hooks
  - Click Sticks
  - Commercial fall protection
    - Engineered systems (cable)
- Fall arrest vs fall restraint

Fall Factor

- A fall factor is a number that assesses a fall's severity
  - 0 = Lowest
  - 2 = Least desirable
- Per OSHA, fall can not exceed 6ft and generate more that 4kN of force on body
- NFPA fall factor is .25
- Place Y-lanyard 6ft off ground then every 3ft. (Waist and shoulder)
- Careful not to "ground out"

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High Directional Anchors

Artificial high directional – an elevated change of direction anchor point used to change the direction of the main or working line.

Types of Artificial High Directional:

1. Artificial
   - Arizona vortex
2. Structural
   - Beams
   - Columns
   - Window openings
3. Natural
   - Trees

Arizona Vortex

- Monopod set-up – minimum of three guys to anchor
- Bipod set-up – minimum of two guys to anchor
- Tripod set-up – minimum of at least one guy to anchor

High Lines

Why?

Advantages

- Patient movement over obstacles
- Access to difficult locations

Disadvantages

- Time of set-up
- Requires team work and knowledge
- Equipment intensive
- Stresses equipment, may cause failure
- First line across space is difficult to set up
- Must be anchored at each end

High Lines:

Types

a. Horizontal
b. Sloping – most common type used in rescue operations

c. Moving control points

Tensioning of high line systems

3 methods most commonly used methods of tensioning

1. 10% rule –
   10’ of slack per 100’ of rope for each 200 lb load.

2. 18:1 rule –
   The total numbers of people hauling, hand over hand, multiplied by the mechanical advantage of the system being used, results not to exceed 18.

3. 3:1 –
   3:1 mechanical advantage connected evenly to each high line and tensioned hand over hand until force is felt by members

Applied forces:

Resultant force – The linear direction of the sum of the vector forces acting on the component

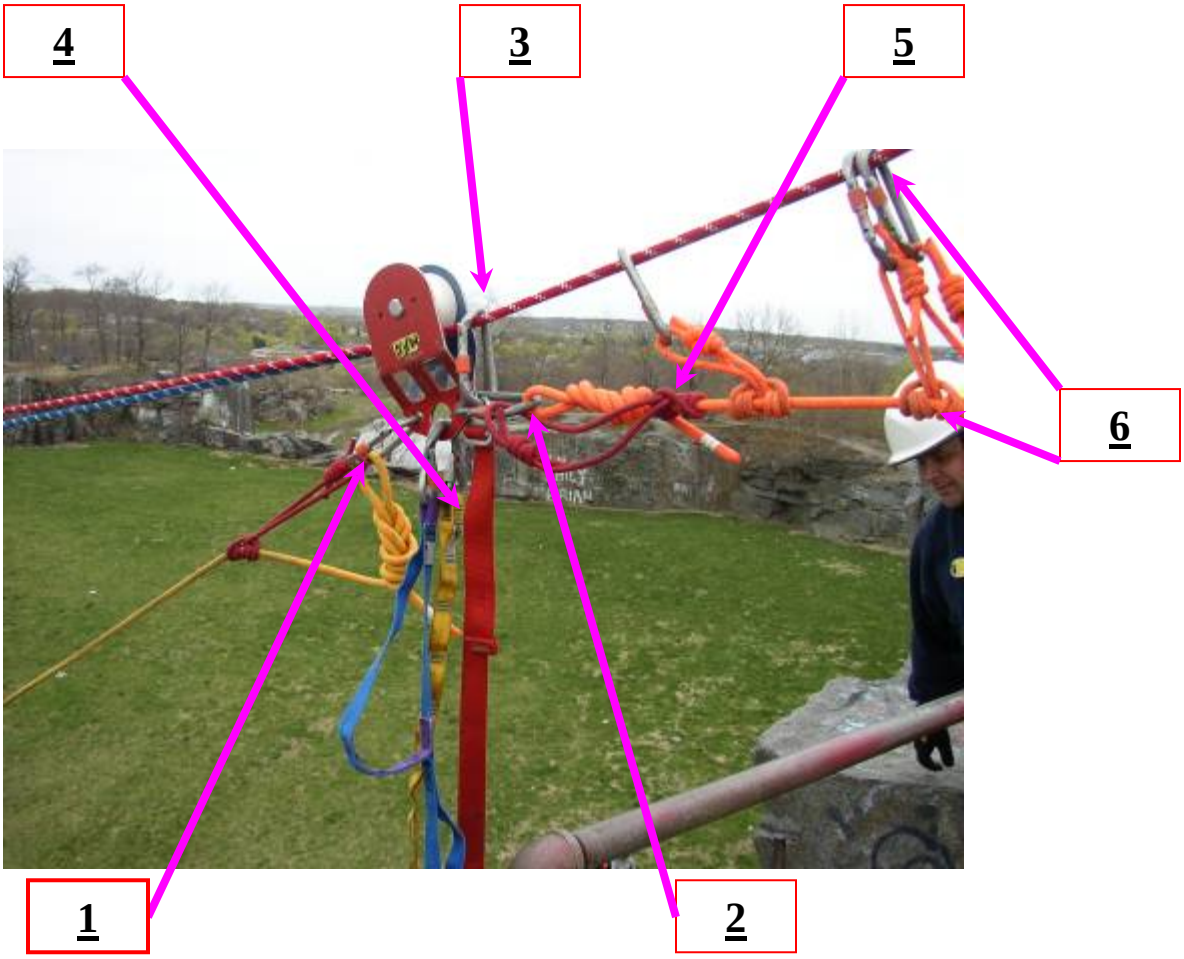
Connection of the rescuer to the system:

2 point connection –

1. Primary attachment point – carabiner, to bottom of Kootenay pulley on track line, to daisy chain or etrier to rescuer’s front d-ring on harness
2. Safety attachment point – carabiner around track lines, attached to pick-off strap, attached to rescuers harness webbing

Connection of Kootenay carriage to track line system: (see picture next page)

1. Lower control point connection
2. Upper control point connection
3. Rescuer safety attachment point
4. Rescuer primary attachment point
5. Soft link to each control point
6. Festoons connection point – approximately every 15’ to 20’


4
3
5
6
1
2


Resultant force

COMMANDS

- SLACK -- let out more rope, introduce slack into the system. *ex. "Slack on blue line"*
- UP ROPE -- take up the slack in the line. *ex. "Up rope on red line"*
- TENSION -- remove all slack and put some load on the line. *ex. "Tension on blue belay"*
- STOP -- this can be called out by anyone, anytime. If you see an unsafe situation or what you think is an unsafe situation call out STOP! With this everything stops immediately.
- ON BELAY? -- This is a question the rappeller asks the edge manager before approaching the edge/window. He is asking if everyone is ready for him to approach the edge.
- BELAY IS ON -- the edge manager answers him, acknowledging that they are ready.
- ON RAPPEL? -- Done after tensioning the system, the rappeller asking the edge manager if he's ready for him to exit the window/edge.
- RAPPEL AWAY -- the edge manager's answer that he is ready for the rappeller to exit.

COMMANDS WHILE ON ROPE

- STOP -- the rappeller telling the edge manager he's stopping.
- WHY STOP? -- The edge manager asking why the rappeller is stopping. *ex. Locking off, adjusting my harness, etc.*
- UNLOCKING -- the rappeller telling the edge manager he is unlocking.
- UNLOCKING -- the edge manager acknowledging the unlocking and that he's ready for it.
- ON RAPPEL? -- The rappeller asking the edge manager if he's ready for him to continue.
- RAPPEL AWAY -- edge manager to rappeller -- ready for you to continue
- SAFE ON BLUE -- rappeller to edge manager -- I am on the blue line and I'm safely on the ground, not off belay at this time.

OFF BLUE BELAY -- rappeller to edge manager -- I am safely off the blue line's belay.

CARE AND MAINTENANCE OF ROPE

DO NOT

- Step on the rope
- Drag rope on ground
- Leave rope under tension
- Smoke around ropes
- Store a rope in a poorly vented area
- Store in direct sunlight
- Expose a rope to high temperature
- Subject rope to chemicals, oils, acids, etc.
- Run nylon over nylon
- Use life safety rope for towing
- Cause undo abrasion to rope
- Do not shock load the rope

DO

- Inspect a rope for damage
- Clean a rope after each use if necessary
- Bag rope, ready for use
- Remove knots as soon as possible

Figure of Eight

Figure of Eight on a bight

Figure of Eight bend

Figure of Eight follow through

Double loop figure of eight

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In-line eight

Off-set eight
(equalizing anchor)

Butterfly knot

Barrel Knot

Water Knot

Over hand Safety