

This Field Operations Guide contains specific information on technical rescue procedures.

## THIS GUIDE IS NOT ALL INCLUSIVE!

It is intended to be used as a tool for training and for quick field reference. Refer to current training manuals and your department policies for detailed explanations. There is no substitute for regular, quality, hands-on training by a qualified instructor.



The techniques and procedures illustrated in this guide follow NFPA standards and OSHA regulations as much as possible. This guide can be used by rescuers at all skill levels but was specifically developed for fully qualified technical rescue technicians. Special operations are inherently dangerous and serious injury or fatality may result from improper performance of these techniques. The author accepts no responsibility for damage, loss, injury or death resulting from information contained in or omitted from this guide.

Thanks to the Phoenix Fire Department and everyone who helped make this guide possible. Special thanks to my friend Ron Jamison for helping to write this guide, Kathy Darrow for editing and to George Drees, Ken Phillips and Jim Frank for great ideas and input.

This guide is dedicated to all those people who go the extra inch every day to make themselves better rescuers.

This handbook is based on the Phoenix Fire Department and Arizona State Fire Marshall's Office technical rescue programs.

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Key procedures in red

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# Technical Rescue Field Operations Guide

## How to use this guide

-  A stop sign icon indicates a hazard warning where improper technique may result in serious injury or death.
-  Text with a red check next to it denotes a key part of that specific procedure.
-  Text with a red check and colored red denotes a critical aspect of that procedure that must not be overlooked.






Red rope in this guide denotes working line.



Belay line has no fill or is grey.

### On checklists:

- A black box indicates an operational level skill
- A red box indicates a technician level skill
-  Remember that this is only a guide. The rescuer must adapt to each situation as common sense dictates!
-  Always be sure the system passes the whistle test, which means if all rescuers were to let go of the systems, no catastrophic failure or injuries would occur.
-  Always be sure all personnel tie in near the edge.

\*Metric measurements are included in parentheses in the rope rescue section and are converted to the nearest centimeter or half meter.

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## NFPA 1670 Standards

NFPA 1670 1999 edition is the current standard for technical rescue operations. Skills and procedures in this guide are categorized according to NFPA 1670 standards where applicable. For example, a command checklist involves scene size-up and hazard recognition. This is an awareness level skill and will have an **A** icon. High angle litter raising is a technician level skill and will have a **T** icon.

Some procedures are not specifically addressed in the NFPA standard and the categorization is interpreted from similar categorized procedures. An interpreted level will have an asterisk next to the icon.

The intent is to make it easy for responders to assess different situations appropriately and to train according to standardized guidelines.

The general definitions of the 1670 operational levels are in Appendix A. Refer to the NFPA 1670 document for complete definitions in each area and for each skill or procedure.

The authority having jurisdiction has final say as to the categorization of each procedure.

**A** Awareness level skill

**O** Operational level skill

**T** Technician level skill

## NFPA 1983, 2001 Edition

NFPA 1983 is the U.S. Fire Service standard for life safety rope and harnesses. It defines all rescue system components, their construction, use, labeling and testing.

A two person system icon means that the procedure is intended for two person loads and any component that will bear the weight of two people must be rated for general use. Light duty components may be part of the system when they are used to support the weight of a single person.

**II** Two person (general use) components

# Risk Management

## **Safety is always our first concern**

At the start of each operation, ask these questions;

1. What is the key problem?
2. What is our plan of action?
3. Why is that the safest plan?
4. What are the biggest risks that we need to watch out for?
5. What is your gut feeling about this plan?

## **Remember**

- We will risk our lives in a calculated way that is appropriate to the situation to save savable lives
- We will not risk our lives at all for that which is already lost

## **Communicate**

- Each operation must have a clearly defined leader
- A decision on rescue or recovery strategy must be made clear to everyone at the outset of every operation
- Speak up if you see a problem no matter how small or obvious it may seem

## **Re-evaluate strategy whenever appropriate**

- When new information becomes known
- When a significant event occurs
- After an extended time period has elapsed

# Incident Management

Most technical rescue incidents are focused around a small number of subjects and can be easily handled with a simple Incident Command System (ICS) structure. Overall command can be any officer but a rescue technician should assume an operations level role and manage the technical rescue portion of the incident.

Each discipline has a specific command checklist with key tactical benchmarks. Use the checklist.

## First Responders

- Take command and size up
- Focus on information gathering
- Identify hazards
- Be certain that the right resources are called early
- Avoid activities marked in red on checklists and in text

## Rescue Technician/Operations Officer (TSO)

- Assume operations control
- Review hazards and critical factors
- Assist with the formation of incident action plan and backup plan
- Assign sectors and deploy resources
- Keep command informed about all phases of the operation
- Communicate with sectors and revise plans as needed

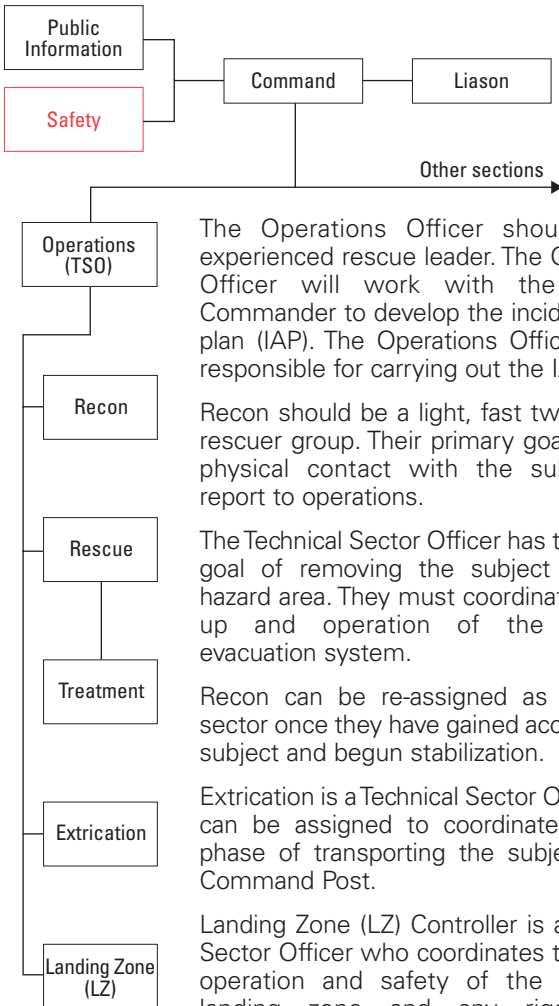
## Rescue Technician/Sector Officer (i.e. Rescue Sector)

- Clearly understand the action plan
- Communicate the action plan to sector personnel
- Supervise task level activities
- Keep Operations Officer or Incident Commander updated on a regular basis

Technical Sector Officer (TSO) is normally a term for the person in charge of a group or sector (i.e. Rescue Sector). In some cases the TSO may function as the overall rescue leader.

# Incident Management

## Mountain Rescue example



The Operations Officer should be an experienced rescue leader. The Operations Officer will work with the Incident Commander to develop the incident action plan (IAP). The Operations Officer will be responsible for carrying out the IAP.

Recon should be a light, fast two or three rescuer group. Their primary goal is to get physical contact with the subject and report to operations.

The Technical Sector Officer has the tactical goal of removing the subject from the hazard area. They must coordinate the set-up and operation of the technical evacuation system.

Recon can be re-assigned as treatment sector once they have gained access to the subject and begun stabilization.

Extrication is a Technical Sector Officer who can be assigned to coordinate the next phase of transporting the subject to the Command Post.

Landing Zone (LZ) Controller is a Technical Sector Officer who coordinates the set-up, operation and safety of the helicopter landing zone and any rigging and transportation performed by helicopter.

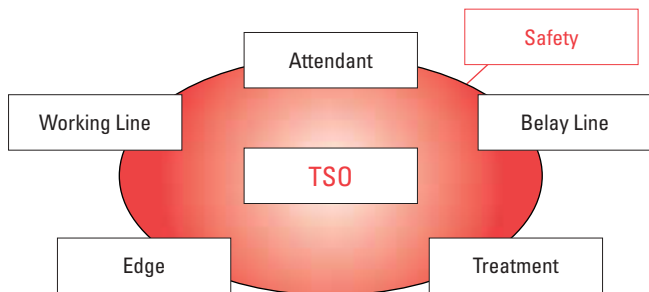


# Time Management

Time is a critical factor. History has proven that performing tasks sequentially to accomplish the objective consumes the greatest amount of time.

## Tips for a safe and fast rescue

- The Technical Sector Officer (TSO) has the big picture, coordinating and fine tuning all parts of the technical evacuation sector
- Multitasking with simultaneous performance of tasks is the goal
- Individuals must work as quickly as possible to accomplish their task, but must not compromise safety for speed
- The TSO must avoid performing hands-on tasks in order to retain overall control of the sector
- Frequent operation specific training is necessary for a safe, effective and efficient team



# Rope Rescue Command Checklist

## Phase I: Size up

- Primary assessment**
  - Secure witness or reporting party (RP)
  - Determine location, number and condition of victims
  - Identify hazards to rescuers (rock fall, terrain etc.)
  - Choose rescue mode or recovery mode
- Secondary assessment**
  - Type of terrain
    - Non-technical (<40°)
    - Technical (>40°)
  - Assess the need for additional personnel and or equipment (helicopter, support truck)

## Phase II: Pre-rescue operations

- Make general area safe (i.e., traffic and crowd control)
- Make rescue area safe
  - Establish lobby control and accountability
  - Designate safety officer
  - Develop incident action plan (see decision tree p. 10)
  - Develop backup plan
- Proper personal protective equipment
- Appropriate rescue and patient packaging equipment
- Equipment for subject (helmet, water, eye protection)
- Pre-rescue briefing

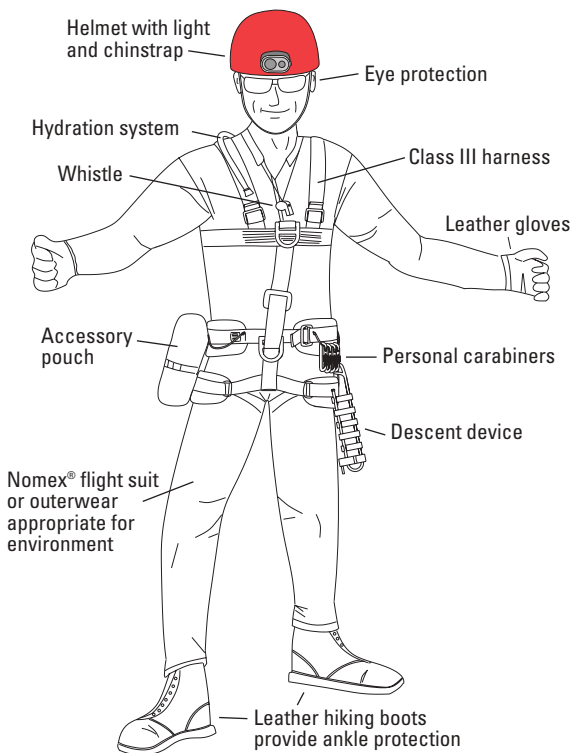
## Phase III: Rescue operations

- Deploy personnel
  - Insertion technique: hike, climb, helicopter, longline
  - Evacuation technique
    - Low angle, high angle raise/lower
    - Helicopter, internal load or longline
- Transfer to Advanced Life Support (ALS)

## Phase IV: Termination

- Removal of equipment
- Personnel Accountability Report (PAR)

# Personal Protective Equipment



## Accessory pouch

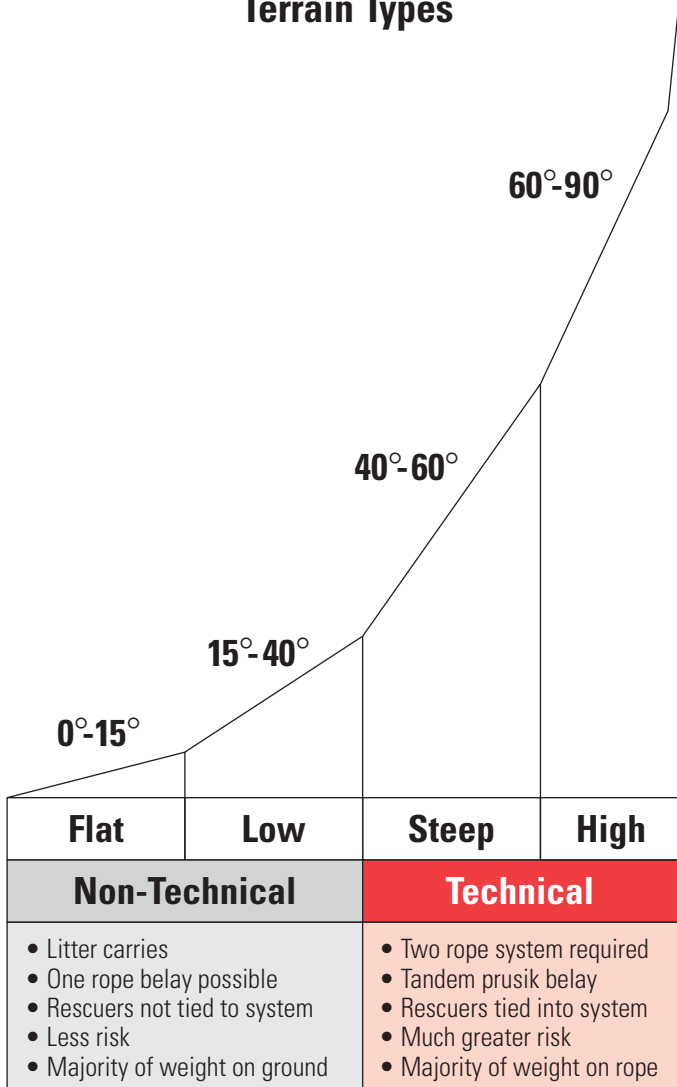
- Personal purcells
- 15 ft. (4.5m) webbing
- Extra batteries
- Energy food
- Trauma shears

## Radio harness

(not pictured)

- Portable radio
- Pen
- Paper

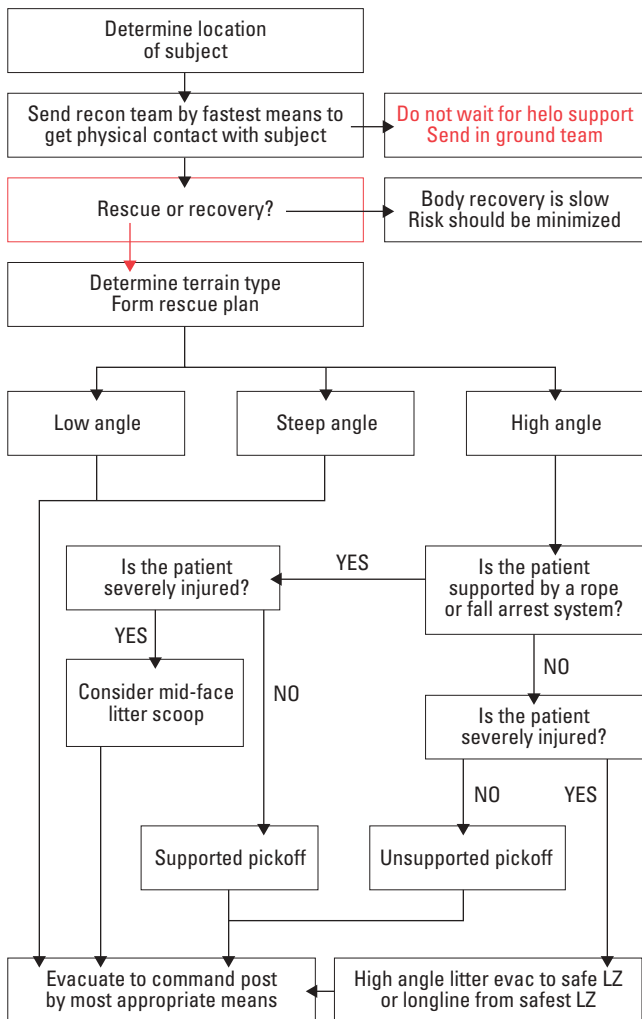
# Terrain Types



**A**

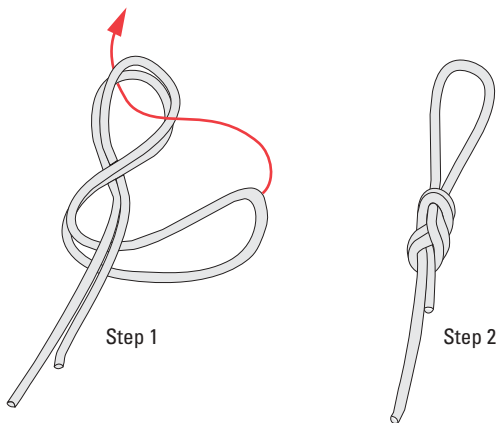
# Mountain Rescue Decision Tree

A

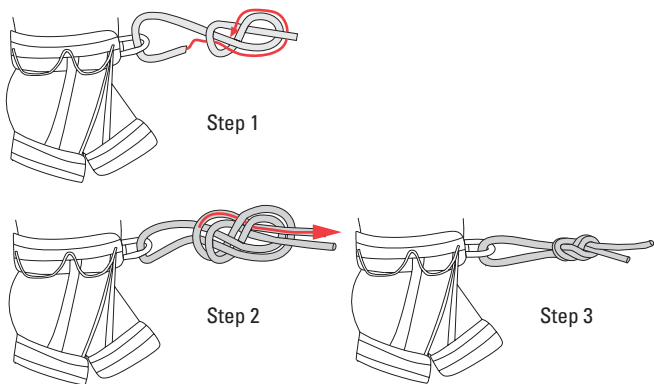


# Basic Life Safety Knots

**Figure Eight on a Bight** (end of rope anchor knot)



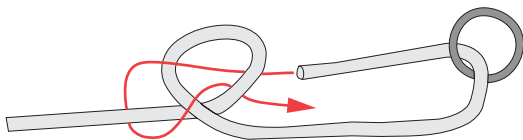
**Figure Eight Follow Through** (tie off for harness or anchor point)



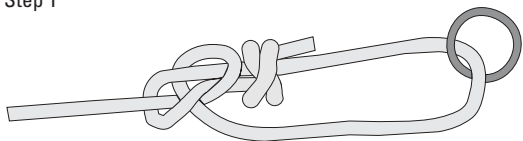
# Basic Life Safety Knots

0

**Bowline** (end of rope anchor knot)

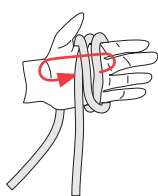


Step 1

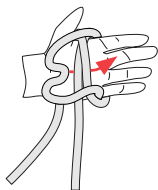


Step 2

**Butterfly** (middle of rope knot)



Step 1



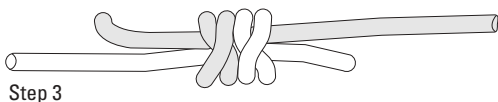
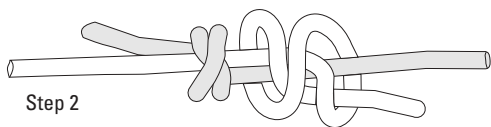
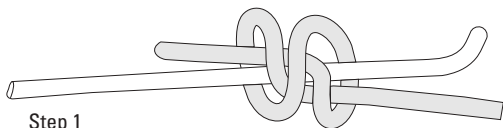
Step 2



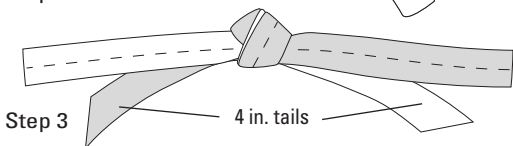
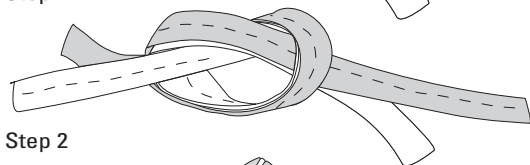
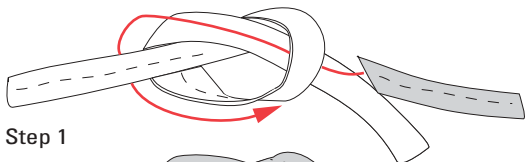
Step 3

# Basic Life Safety Knots

## Double Overhand Bend (tie two ropes together)



## Water Bend (tie webbing together)

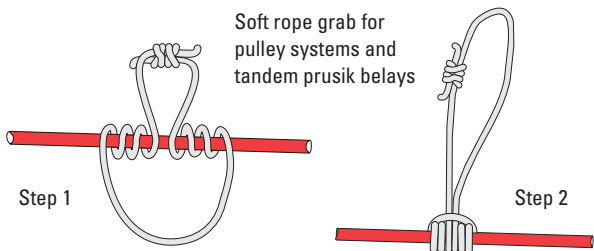




# Basic Life Safety Knots

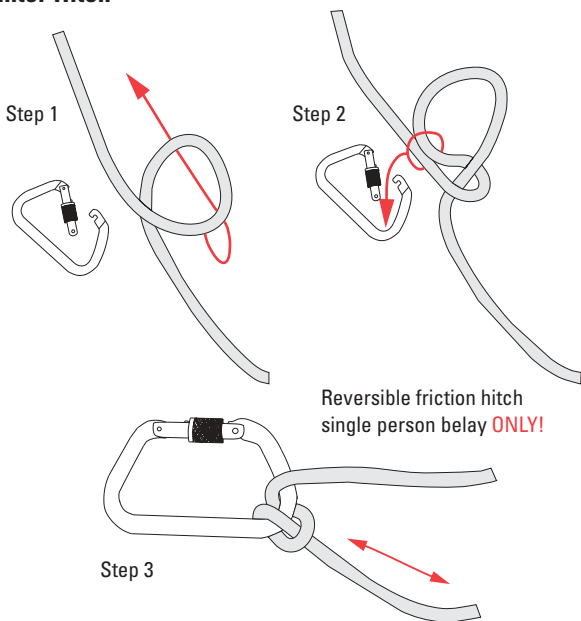
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## Prusik Hitch



Used in pairs, 54 in. (137cm) and 66 in. (168cm), prior to tying for tandem prusik belays

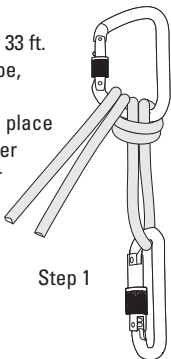
## Münter Hitch



# Load Releasing Hitch (LRH)

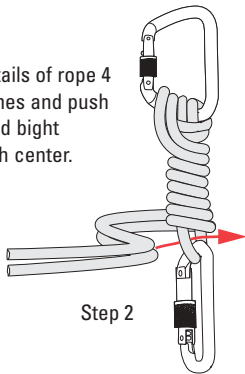
- Component of tandem prusik belay
- Used for knot passing
- Made with 33 ft. (10m) 9mm rope and two steel carabiners

Find middle of 33 ft. (10m) 9mm rope, clip bight with carabiner and place doubled Münter Hitch on other carabiner.



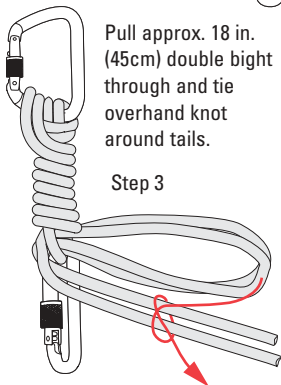
Step 1

Wrap tails of rope 4 to 5 times and push doubled bight through center.



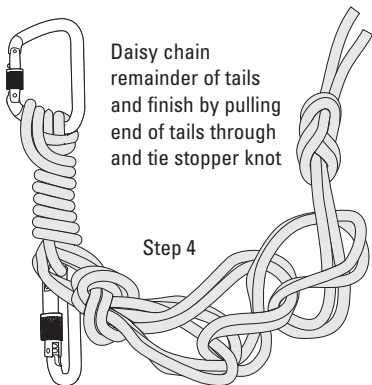
Step 2

Pull approx. 18 in. (45cm) double bight through and tie overhand knot around tails.



Step 3

Daisy chain remainder of tails and finish by pulling end of tails through and tie stopper knot



Step 4

# Personal Purcell Prusik System

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## Uses

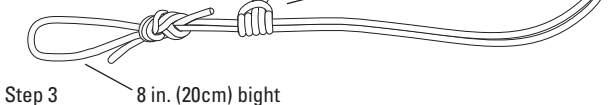
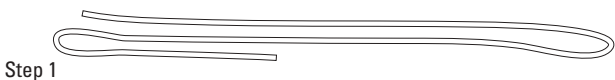
- Ascending a fixed line
- Self rescue
- Team based pick-offs
- Litter attendant tie in
- Travel restraint near edge for edgemen and spotters

## Construction

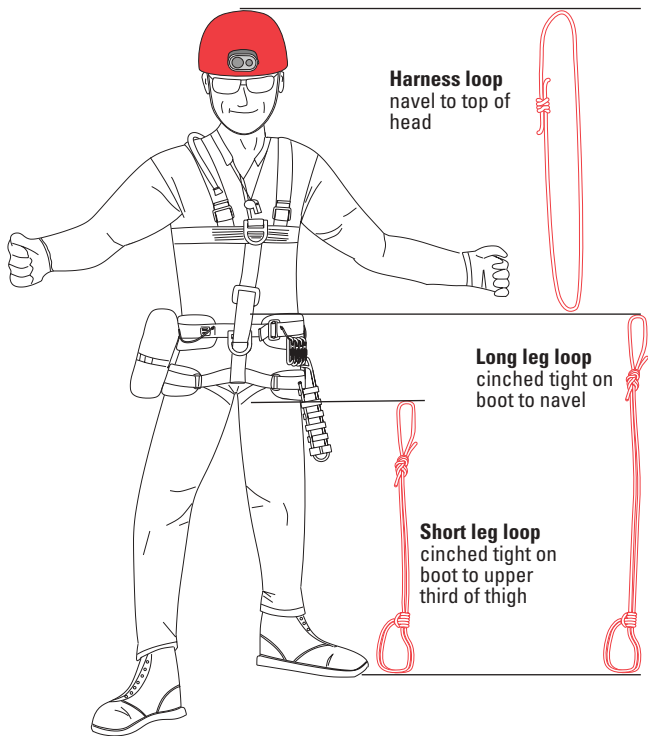
- 33 ft. (10m) 6mm accessory cord
- Size anatomically for individual as shown on sizing illustration
- Dimensions shown are for tied and finished purcells not hitched to rope

Figure eight bend made  
with bight and tail

**Light use only!**



# Sizing Personal Purcells



- ✓ These prusik lengths are approximate and will vary from individual to individual based on anatomical reference points and personal preference. The harness loop must be long enough to prusik onto the rappel line above the descent device and clip into your harness.

## Self Rescue

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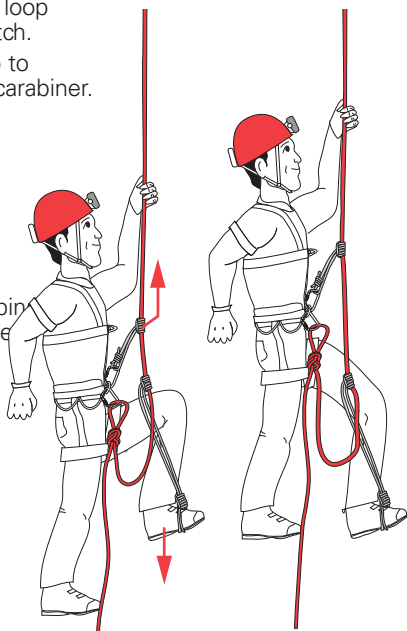
A rescuer must always be prepared to perform self rescue procedures, specifically the ability to ascend a fixed rope, free a jammed descent device, pass a knot on rappel or any combination of the above.

**Warning!** The belay rope has been left out of this illustration for clarity and also to make the point that in a self rescue situation a belay might not be available. *Extreme* caution is warranted when there is no belay. An option is to tie a bight into the rope below the leg purcell and clip it to the harness. Tie a new bight every 5 linear ft. (1.5m) of rope climbed and clip to harness.

✓ **Always use a second rope belay whenever possible!**

### Ascend fixed rope

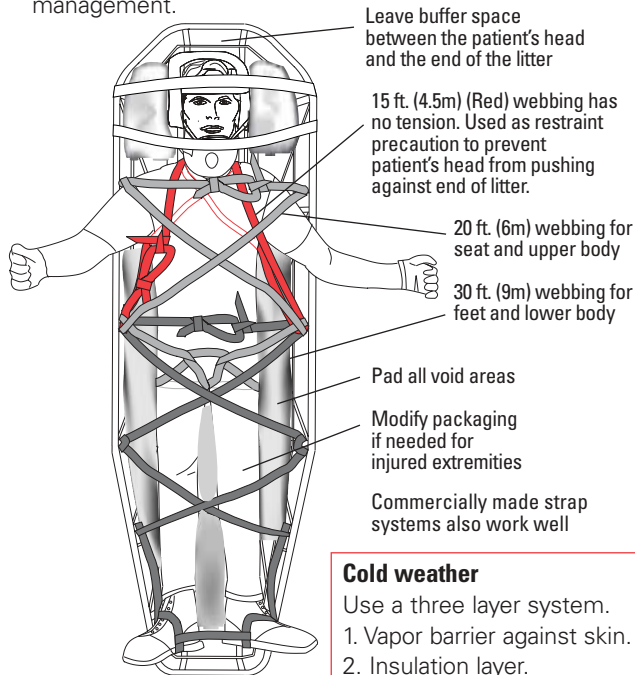
1. Attach harness prusik loop to rope with prusik hitch.
2. Connect harness loop to harness with locking carabiner.
3. Attach climbing purcell to rope with prusik hitch.
4. Place foot into small loop and cinch tight onto foot.
5. Sit back onto harness prusik and move climbing prusik up toward harness prusik with free hand.
6. Stand up onto climbing prusik and move harness prusik up as far as possible.
7. Repeat this process until reaching destination or until problem is solved.



# Patient Packaging

The following five points should be patient packaging goals.

1. Immobilize the patient to minimize movement no matter what position the litter is placed in.
2. Use plenty of padding under the patient and in all voids.
3. Protect the head and face from debris and vegetation.
4. Protect the patient from the elements both hot and cold.
5. Give special consideration to vital signs and airway management.



✓ This illustration is but one example of a number of techniques that can be used.

## Cold weather

Use a three layer system.

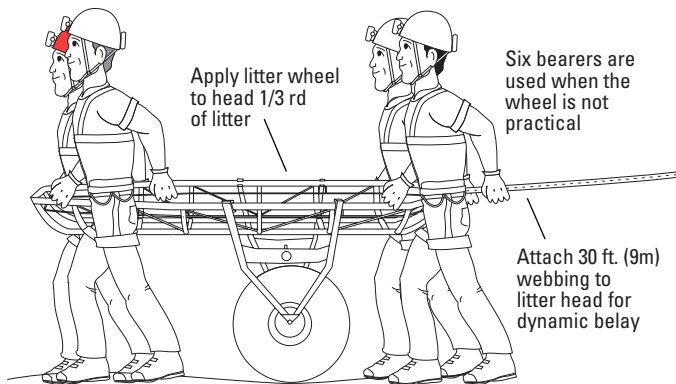
1. Vapor barrier against skin.
2. Insulation layer.
3. Weather barrier.

Heat packs must be added if the patient is hypothermic or if the evacuation will take longer than 30 minutes.

## Low Angle Evacuation 0° - 40°

0

- Majority of weight on ground
- 4 to 6 bearers
- Litter wheel optional depending on terrain
- 15 ft. (4.5m) carry strap for each bearer optional
- Single belay line optional depending on terrain
- Use tandem prusik for belay
- Do not load belay line or use to lower



### Caterpillar pass

- Consider caterpillar pass to negotiate short sections of technical terrain
- Get solid footing and stay in position while passing litter hand to hand
- Very effective on short sections of steep and high angle obstacles
- This is an effective technique but at least 10 or 12 bearers are desirable to accommodate personnel rotation
- Consider belay line

# Anchor Systems

## Definitions

- Natural anchors: naturally occurring trees and rocks
- Artificial anchors: anything placed by man including fire trucks and structural members
- Bombproof anchor: an anchor that you confidently believe will hold the intended load and any potential impact force unintentionally generated by the load
- Marginal anchor: an anchor that you do not believe to be bombproof
- Single-point anchor: single point of origin
- Multi-point anchor: a collection of marginal point anchors connected into a bombproof anchor system
- Back-tie anchor: a marginal anchor in a good location that is linearly connected with a tensioning unit to a bombproof anchor somewhere back from the edge

## Concepts

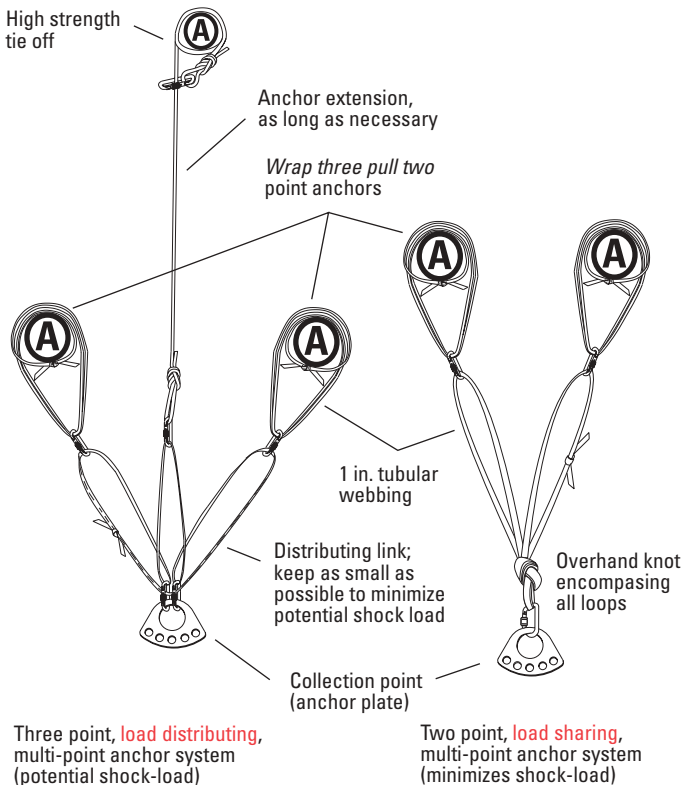
- Safety test all anchors in the direction of use with a force comparable to the working load
- Watch for signs of weakness or failure
- Distribute force equally between all anchors in a multi-point system
- On multi-point anchors, keep the distributing link small to minimize any potential impact force
- Always try to have independent anchors for the working line and belay line
- Choose strong points like joints and corners on structural members for anchors
- Avoid mid-span anchor points on structural members if possible
- When using pre-sewn straps, prevent side loaded or tri-loaded carabiners



# Anchor Systems

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- Keep angle less than  $90^\circ$
- Commercially made straps are acceptable
- Commit entire ropes to the anchor if necessary
- Pad all sharp edges

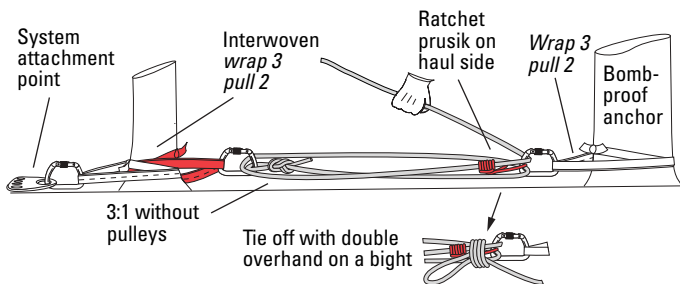


✓ Always double-check everything!

## Back-Tie Anchors

A back-tie anchor is used to focus a marginal anchor to a bombproof anchor. It is built with low-stretch rope and a system prusik.

1. Construct back-tie system as shown with ratchet prusik on line closest to haulers.
2. Three wraps of 1/2 in. (13mm) rope is ideal but distance between anchors and available rope may limit number of wraps.
3. Pull tension on system and set ratchet so that all ropes stay under tension but do not damage forward anchor.
4. Tie off back-tie tension unit.



- ✓ Keep back-tie anchor in line with the fall line.
- ✓ As a rule, look for bombproof single-point anchors and linear anchors for rescue.
- ✓ Multi-point anchor systems made of marginal anchors should be the rare exception.

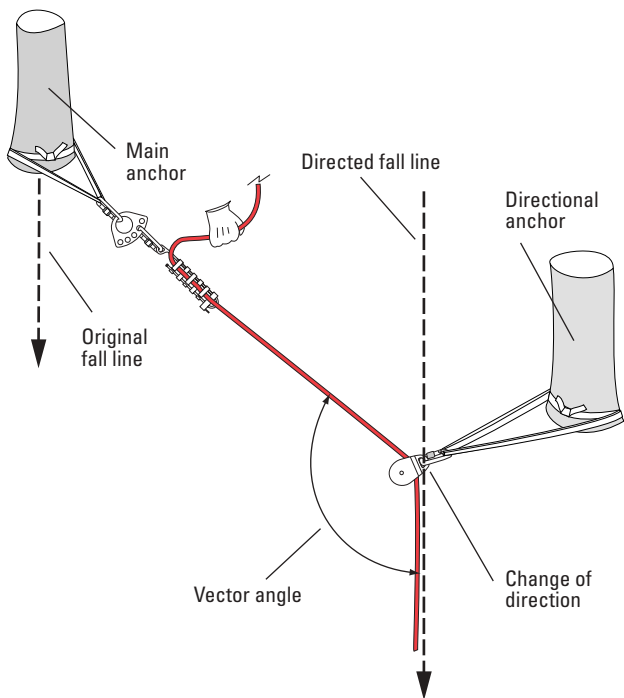
## Directional Anchors

0

The fall line refers to the natural plumb line always present as a result of gravity. It is affected and changed by the angle and aspect of the slope.

The location of suitable anchors relative to a suitable fall line is always a critical factor. Occasionally, it is safest to redirect the system into a directed fall line with a directional anchor.

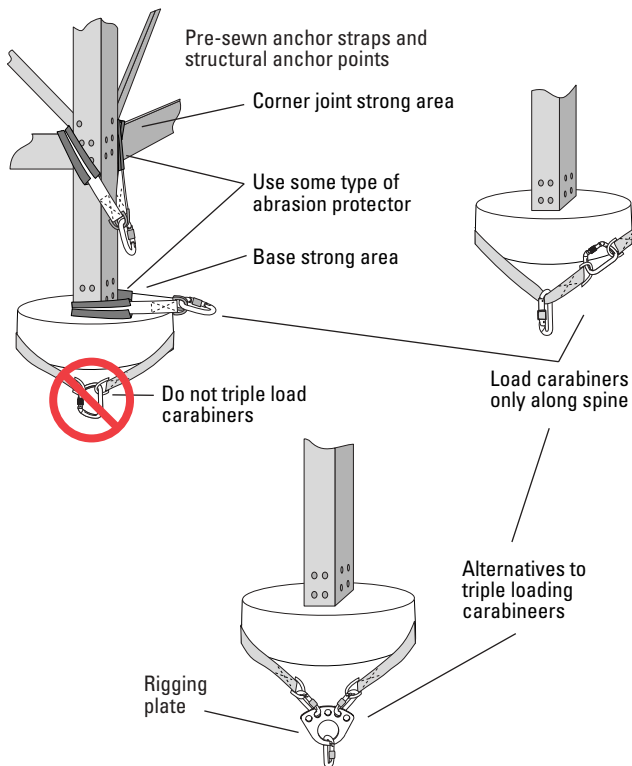
Caution: a change of direction can place up to 200% of the load on the directional anchor depending on the vector angle. A  $90^\circ$  vector angle will place approximately 140% of the load on the directional anchor.



# Structural Anchors

## Pre-sewn anchor straps

- Fast to set up
- No knots
- Rated auxiliary equipment

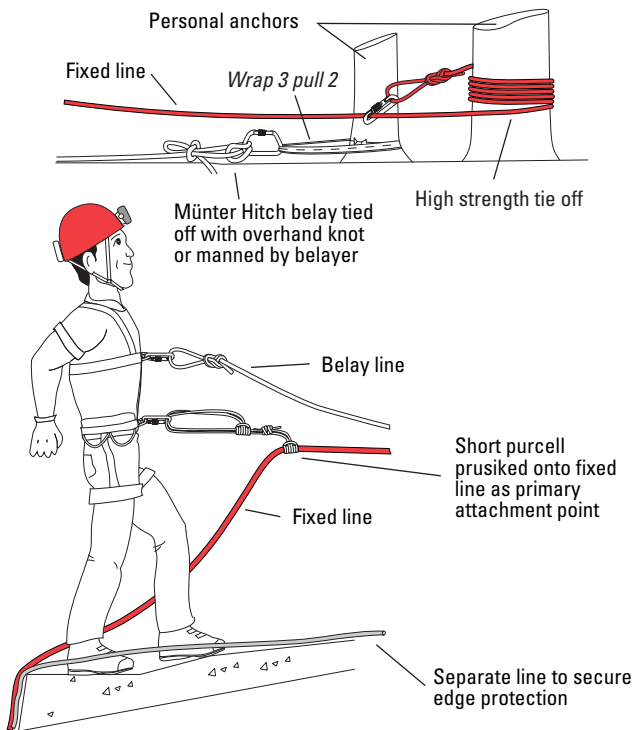


## Fixed Belay for Edgemen

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Edgemen must have two points of contact while working near the edge. The rescuers feet count as one point provided the rescuer does not intend to put body weight on the belay line and that the edge is not sloping.

An unweighted belay line is required if the edgemen intend to put body weight on their primary restraint.

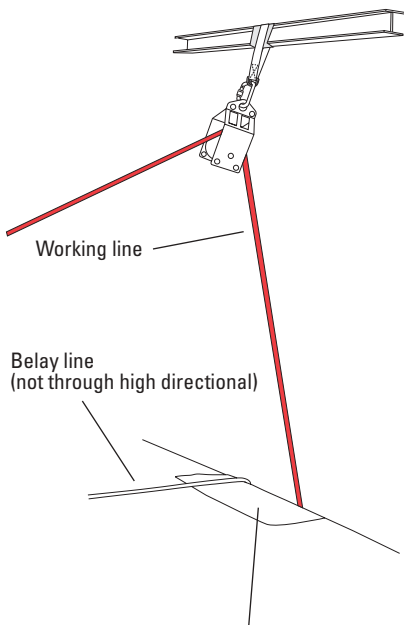


# Edge Protection

- Do not put belay line in high directional
- Avoid standing under loaded working line
- Be certain to secure low directional to prevent losing it

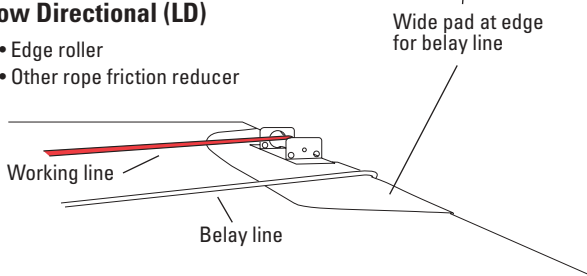
## Structural High Directional (SHD)

- Standard pulley
- Knot passing pulley



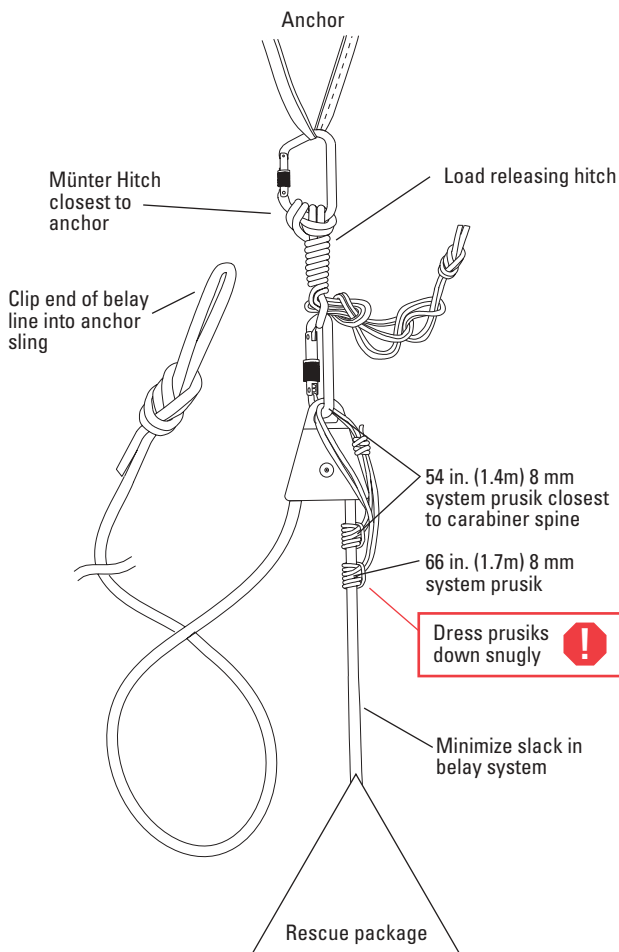
## Low Directional (LD)

- Edge roller
- Other rope friction reducer



# Tandem Prusik Belay Setup

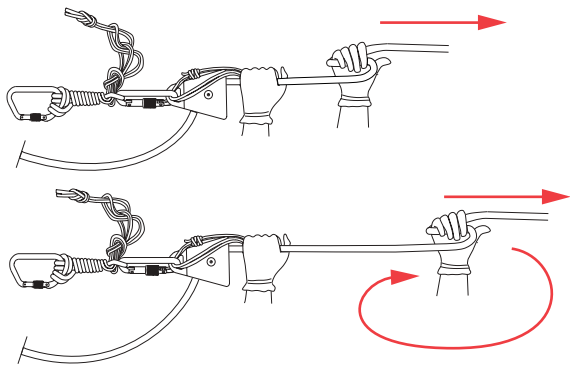
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# Tandem Prusik Belay Operation

## Lower

1. For lowering system, place one hand on both prusiks and create a z-turn with the rope on the load side with the other hand.
2. Hold the z-turn and let rope out 1 to 2 ft. (~.5m) or 2/3 arm length.
3. Begin to turn z-turn hand while feeling and maintaining the tension on the rope.
4. Quickly move the z-turn hand back toward the prusik hand and make another z-turn.
5. Repeat this process always keeping a feel for the rescue package.



## Raise

1. Pull constant tension on the free end of the belay rope.
2. Let the prusik minding pulley (PMP) mind the tandem prusiks.

