Loveland Fire Rescue Authority
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SPECIAL OPERATIONS: ROPE RESCUE: ANCHOR SYSTEMS (1.1)

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- **Version 1.0**

  - Anchor Systems
  - NFPA 1670, 1006

TASK SKILL DESCRIPTION AND DETAIL

Anchoring is at the heart of technical rope work and rigging. Within the climbing and rope rescue communities, much of the anchoring involves employing the use of trees, rock mass, terrain features, vehicles, devices such as camming units, ice screws and snow pickets. Because of the inherent uncertainty regarding the respective strengths of these various anchor points, a completed anchor system often involves multiple anchor points all configured together to produce a master point of attachment (aka **focal point**) for the rope and/or rigging device. (RFR)

PPE:

Personnel building anchor systems have the potential to get cut, fall, have things fall on them etc. so at a minimum all personnel should have gloves, boots and helmet. If anyone will be building anchors near fall potential or "hotzone" then that person shall also have type III harness and fall protection in place prior to working in that area.

Anchor Systems:

An **anchor** is the object or objects that will hold the load, the **anchor system** is how and in what manner the anchors will be utilized and attached to form our focal point.

All anchors must be able to hold the anticipated load that will be applied to it, in the direction from which the load will be applied. This should be determined by the team leader or control. A 10:1 safety factor shall be included to compensate not only for the anticipated load, but also for unanticipated loads, dynamic loads and hauling system stress. Ensure that a direct line is set between the anchor and the load to prevent a pendulum of the load i.e.; focal point in the direction of anticipated load.

The equipment we use is called either "hardware" or "software". It is carried in our anchor packs located on R2, TW6, R6, L6, FIT 2, and the large Gator. Other rope and software can also be used but **only if it is life safety, do not use Utility rope.**

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The location varies depending on apparatus. The bag style and color should be consistent black for "Blitz" and Green for "anchor pack".

Anchor Pack: (Green) Contains all the software and hardware needed to construct an anchor. Contains an inventory of exactly what the contents should be, each day the inventory should be rechecked, sealed and marked with your equipment number.

Blitz Pack: (Black) Contains equipment for a rescuer and victim, like a harness, helmet, safety glasses etc. Contains an inventory of exactly what the contents should be, each day the inventory should be rechecked, sealed and marked with your equipment number.

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Typical contents of an Anchor Bag.

This differs from the contents of a "Blitz pack"

Vehicles:

Our apparatus have many different and versatile attachment points. Use of apparatus should be preplanned and training performed to ensure proficiency. They are a great anchor for many operations in that we all come in them and they can be maneuvered into position.
All vehicles utilized as an anchor point must be secured by having keys removed, apparatus off, parking brake set and wheel chocks applied. Ensure any anchor point used on a vehicle is designed for that purpose or is structurally significant**. IMPORTANT:** Do not tie soft gear in a location where it would be in contact with hot components or exhaust, damage and possibly failure may occur.

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Anchor attachment point under engine


Anchor around axle with webbing


Webbing through wheel


Webbing through wheel, single

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Webbing around axle and over tire- Advantage is higher tending stance.

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Example of one of many ways to obtain high directional anchor. Pulley is not required here but allows for transition to haul if necessary or an anchor that can be tensioned. This option available on Rescue 2

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Same high point used in tensioned anchor or short throw haul system.

There are many adaptations to the use of the high point anchors on Rescue 2 shown here is only for awareness of high point options with Rescue 2 on scene.

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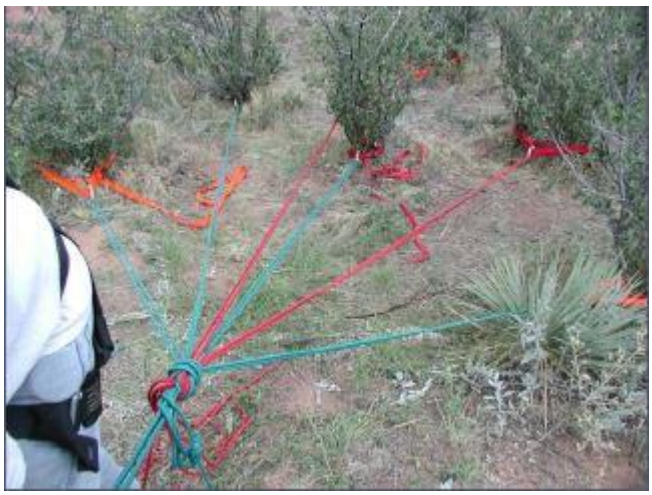
Trees:

Ensure that any tree used has sufficient girth to hold the expected load. Study soil type and root systems to determine if trees are on stable solid footing. (Water soaked ground, sand, shallow roots etc. **may** be examples of unstable soils or root systems)
If a single "bombproof" tree is not available, multiple trees can be used with multipoint anchor or a backup anchor in line with primary anchor.

1 anchor tied back to the base of a second anchor in line.



Multiple "iffy" anchors equalized to one focal point. **(This is an example of multipoint, not a recommendation to use small bushes)**

Secure primary anchor tree with to be utilized with sufficient strength cordage and with enough length to be fixed and focused. (the knot will use some of the length)

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Material	Strength
7mm Cord	10 KN
8mm Cord	13-15 KN
11mm Rope	30 KN
13mm Rope	40 KN
Aluminum Carabiner	22-30 KN
Steel Carabiner	40 KN
Pulley	36 KN
Brake Rack	Breaks rope at 26 KN
25mm Tubular Webbing	18 KN
25mm Flat Webbing	26 KN
W2P1 (Tub/Flat)	24-26 KN/32 KN
W3P2 (Tub/Flat)	35-40 KN/46 KN
Radium Release (RRH)	35+ KN
Tandem prusik	Clutch at 10-14 KN
Single prusik	Clutch at 9-13 KN

Use this table to approximate material strengths in the system. Don't forget to subtract **1/3** approx. if there is a knot in the material.

I.e.; if an 11mm rope has a figure 8 on a bight in the system the strength is reduced from 30kn to 20kn.

Rigging Plate	36kn
Kootenay Carriage	40kn
Micro Rack	46-56kn Breaks 11mm rope @26
Conterra Scarab	40kn Breaks 11mm rope @22
540 Rescue Belay	70kn (NFPA requires it to say 36)
Radium Release Hitch	35kn using 8mm cord
Prusik minding pulley	36kn
Large Diameter Pulley	32kn 2" or bigger sheave

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Ensure anchor strap is long enough to prevent side loading of carabiner **(both anchor ends align with spine of carabiner**)

"Wrap 3 pull 2" with 1" tubular webbing. Note: Knot on load side of tree.

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The “High Strength tie off” or “tensionless anchor” is simple and uses full strength of the rope itself. Most often used in a highline environment but offers simplicity and strength in other areas also.

Minimum size of tree is **10** times the diameter of the rope

Webbing basket anchor analysis:

1” tubular webbing: 18kn – 1knot =12kn

4 strands = 48kn (anchor)

Steel carabiner = 40kn

11mm rope= 30kn – knot = 20kn (weakest link)

2kn load times 10:1 safety factor = 20kn

System is sufficient.

Note: Main line and belay line would each need separate anchor to be redundant. So this anchor could be used as the main line anchor and the belay anchor would need to be built separate from our main line hardware. Can use same “bombproof” tree though.

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Rocks:

In many situations west of town vehicles and trees may not be available for anchors. In these cases often times rock can offer excellent anchor potential. Length is often an issue when using rocks as solid rock anchors are typically large in size and require a lot of material. Webbing may or may not be suitable in those situations. Several options include using unused rope, long strands of cord (8-9mm) to make multistrand, fixed and focused anchor points. Ensure the rock or boulders are of sufficient size to undoubtedly hold the expected load, and there is no chance the rope could pull under/over the rock when loaded.

Simple "wrap 2 pull 1" ensure rock is sufficient for load, or tie rock off to other anchors.

Using the table above, tubular webbing has a strength of 18kn. With a knot- 12kn with 2 strands – 24kn.

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An anchor strap could be used here but note the "side loading" of the carabiner. This anchor strap would need to be longer or use webbing, cordage or rope instead

Note the above anchors are multistrand anchors using rope. They are fixed and focused in the direction of pull, each anchor designed to carry equal amounts and no interior angles are at or over 90 degrees.

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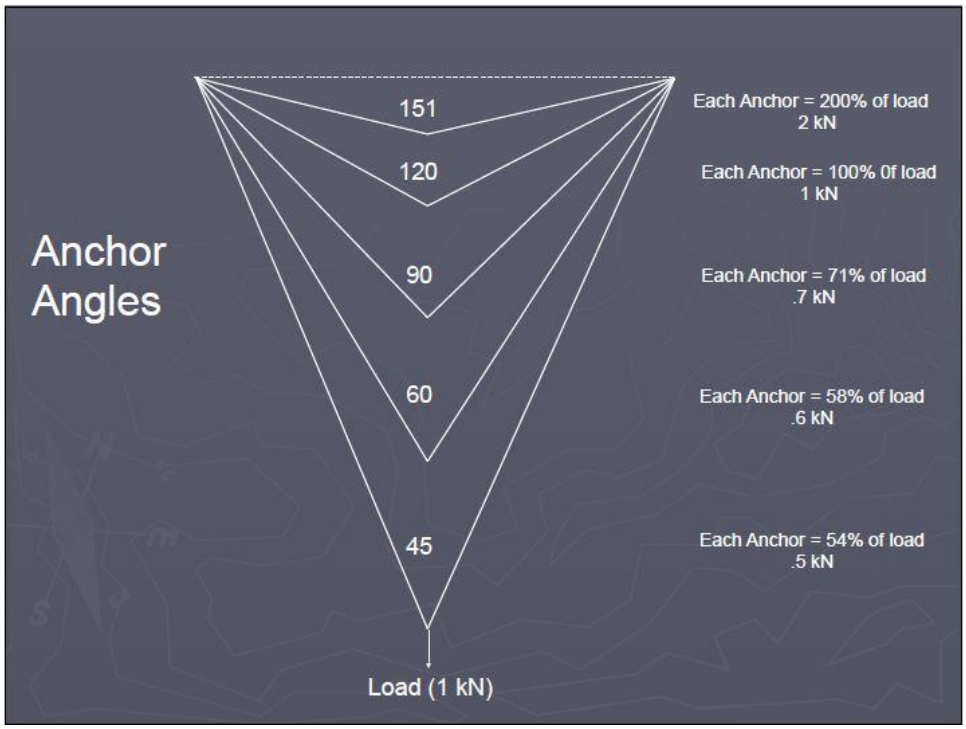

Ensure that the "critical angle" is less than 120 degrees. The reason for this is that each anchor will see more than the actual load if this angle is exceeded. Note that if the angle is less than 45 degrees each anchor only sees half the load.

Test the anchor prior to the application of its intended load by "pre-loading" to test the alignment and reaction of the system components. Analyze anchor to determine if it meets the EARNEST-R principle:

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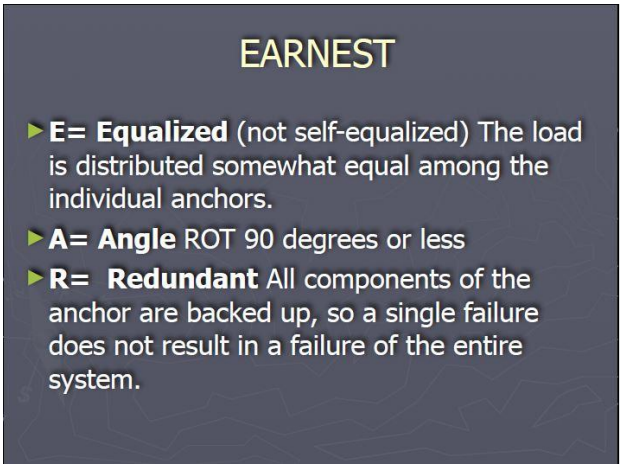

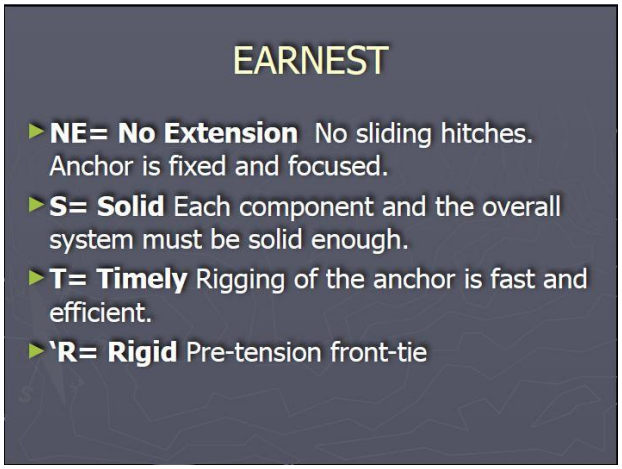

System safety check:
Recognition that any rope based rescue system is no stronger than its weakest link, prompts a thorough safety check of any rope system prior to deployment. These system checks are three fold and are performed by multiple persons to eliminate the potential for human error. The three tests are a "Critical Point Test", a "Whistle Test", and a "Touch Test".

Critical Point Test:
A Critical Point Test requires that rope system in its entirety is looked at to ensure that the failure of any one part of the rope system, either human or equipment, will not result in a total system failure (domino effect). A Critical Point Test can be performed by asking "What if" type of questions in regard
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to the rope system, such as "What would happen if the Track Line failed", or "What would happen if the Main Line anchor failed".

Whistle Test:
The passing of a Whistle Test means that if in theory at any point a whistle were blown which signals all personnel to "let go" of the rope or equipment that they are operating, nothing catastrophic will occur to the live load that is depending on the rope systems for their safety.

Touch Test:
The Touch Test is a verification of the integrity of the entire rope system with a hands on check of every component of the rope system from one end to the other prior to deployment. The requirement that the individual

performing this task physically handle each component that he/she is examining focuses the examiners attention on the task and eliminates a "casual glance" type of inspection.

Redundant system check:

To reduce or eliminate the potential for human error, the above tests shall be performed by multiple persons.

Once all systems have been double safety checked, no change to the system will be allowed under any circumstance without the approval of the Team leader, and all such changes that are approved of shall be double safety checked prior to deployment of the rope systems.

Task Skill Instructional Requirements and Implementation

This heading includes information about the following:

- Associated power point presentation and lesson plan for instructing on the task (locations on the V drive within *Training Materials of the Fire Training Division Folder*
- Associated PPE required for instructing the task
- Primary progression steps for the development of the task
- Evaluation criteria for observing knowledge, skills and abilities
- Safety criteria when instructing on this task

Reference Information

- NFPA 1006 6.1.3
- NFPA 1670 5.3.2 Operations Level
    - 5.4 Technician level
- Rigging for Rescue Technical Ropework Seminar handouts
- Zone 3 Technical Rescue Manual
- West Metro Rope Rescue Presentation