Fresno Fire Department Technical Rope Rescue Guide

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INTRODUCTION

The Fresno Fire Department responds to numerous types of calls to include technical rescue emergencies. The Department operates an Urban Search and Rescue (US&R) team for technical rescue emergencies not only in the City of Fresno, but throughout the County and State. The purpose of this guide is to provide safe operating guidelines while performing technical rope rescue operations.

The following guidelines apply to Fresno Fire Department members while working on scene of a technical rope rescue in conjunction with the US&R team.

Operational Guideline for Rope Rescue

The goals of this operational guideline are to save and protect lives and mitigate any hazardous condition that may arise as a result of a technical rope rescue incident. This guide is intended to assist engine and truck companies in the early stages of a technical rope or high angle incident.

Response

The typical assignment for a technical rescue incident consists of the first in engine company, closest truck company, US&R company, engine assigned to the US&R company, tower assigned to the US&R company, closest Battalion Chief, and an EMS unit.

Upon confirmation of a confined space rescue, the incident commander is to request the following additional resources, as needed:

1. Additional units: Fire, mutual aid, EMS
2. Urban Search and Rescue (US&R) coordinator
3. Police
4. Public Information Officer
5. Hazardous Materials Team for atmospheric monitoring equipment

Personal Protective Equipment

Protective clothing is to be worn as required by the situation, depending on evaluation of the hazards. The following is the appropriate level of protection to be utilized in rope rescues: steel toed boots, long pants (i.e., BDU's or grass pants), long sleeved shirt (i.e.,

BDU or grass pants), gloves, eye protection, and helmet (i.e., rope rescue type helmet with a three-point chin strap is recommended).

A higher level of protective clothing may be utilized at the discretion of the incident commander if conditions warrant.

Primary Assessment

Scene safety

1. Are fire department members and bystanders in a safe location? Is the victim located in a stable location (tied off or supported in a stable location)?

    a. In the path of high winds

    b. Away from any hazards

    c. Vehicle traffic

    d. Falling objects

    e. Is this a confined space?

Find out what happened, retain the reporting party close to the incident command post to utilize as a primary source of information. Attempt to find out which events led to the activation of a rescue call. Rescuers should be alert to signs of mechanical or structural failure.

Size up the victim's condition. A suicidal victim will pose a different problem as opposed to a rope access worker stuck on top of a water tower. Find out if the victim is conscious or altered, if they have any injuries, when the last time someone had contact with the victim, or if there are multiple victims. Many times, hikers get stuck in a low angle situation and bystanders or would-be rescuers become victims as well, so be alert and ready for multiple victims.

Evaluate the survival profile of the victim. Crews must do a risk assessment of the operation based on the risk management policy.

First-Arriving Company

For the first arriving company officer, establish command of the incident, isolate, and deny further entry into the hazard/rescue area. This will allow you to get your head wrapped around what the incident is and ensure your crew do not become victims in the process.

Establish communications with the victim as soon as possible and if feasible. Do not put your crew or yourself in a hazardous spot to try and make communication with the victim. On jumper calls, the law enforcement agency that has jurisdiction will probably be first on scene and will initiate and retain contact.

If possible, attempt a non-entry rescue of the victim. Be aware of on-site retrieval devices, the victim may have a retrieval or safety line attached to them that can be attached to a piggyback system. If the victim is conscious, lowering a rope to them and having them connect to themselves is a great non-entry rescue. Evaluate if the victim can be secured to a stable object to prevent them from falling or further becoming trapped.

Crews must ensure that they lock out and tag out any possible mechanical, electrical, atmospheric, and/or engulfment hazard that may be present in a technical rescue. These hazards are typically found in confined space rescue incidents but are not limited.

If not already enroute or ordered, the first in company officer needs to consider requesting the balance of a US&R assignment or special calling additional units if the possibility of multiple victims is present. Additionally, Fresno County Fire has a US&R resource that may be requested as mutual aid if the incident complexity is warranted.

Secondary Assessment

Before any rescue is attempted, the incident commander must determine as much information as possible. Critical information includes which hazards may be present to the victim and rescuers. Are there hazardous materials, mechanical, electrical, or engulfment hazards? Identify what you have locked out and tagged out and who accomplished it. If the responsible party for an industrial complex did lock out tag out, ensure you verify that it has been done correctly.

Determine the exact location and confirm the number of victims. Find the best access point for the rescuers to get to the victim. In technical rope rescues, lowering the victim to an access point where a vehicle or ambulance can pick them up is a better option than rigging a raising system.

First-Arriving US&R Company

When a US&R response is initiated, the first arriving US&R company officer should assume the rescue group supervisor role after contacting the IC and re-assessing the situation. Early consideration for additional rescue resources is key to the success of a technical rescue.

The rescue group supervisor should establish a good perimeter and control zones to limit rescue personnel and bystanders into the rescue area.

1. **Hot Zone**: Area involving the victim, the most hazardous area

2. **Warm Zone**: Area which can potentially become hazardous and involve a rescuer or bystander

3. **Cold Zone**: Area at a safe distance from the hazard and cannot quickly become hazardous

    a. Size of zones to be determined by:

        i. Structural stability

        ii. Wind direction

        iii. Atmospheric conditions

The rescue group supervisor in conjunction with the IC should create an Incident Action Plan (IAP) and continue the planning process.

First Arriving Battalion Chief

When the first arriving Battalion Chief arrives, they should consult with the IC and Rescue group supervisor and get a status of the incident. They should then assume command of the incident, redirect strategy mode based on the incident priorities, and consider additional resources if not already ordered. They can also redirect actions of on-scene companies, direct or redirect companies that are still incoming, and provide logistical support for the on-scene operations.

Additionally, one of the tasks that is commonly overlooked by first arriving companies, is the need for relief or rehab crews. In extended technical rescue incidents, the ability to have additional crews and recalled US&R members allows the rescue to continue regardless of environmental conditions.

PRE-ROPE RESCUE

The following ICS positions should be assigned prior to beginning a rope rescue:

An Incident Commander and Command Staff. The Liaison Officer should act as a technical liaison to the facility personnel as appropriate, in addition to coordinating with other agencies.

A Logistics Section will be responsible for coordinating requests for additional rescue equipment and is beneficial when the IC is getting outside of their span of control.

An Operations Section is responsible for developing a complete rescue plan to include access to the patient, a packaging plan, and a retrieval plan. The Operations section will coordinate the rescue efforts of on scene companies and be responsible for operational decisions pertaining to the rescue plan.

The Rescue Group Supervisor will identify the rescue team, retrieval team, haul team, and edge person. The Rescue Group will also conduct a safety check on all rescue group personnel unless a Rescue Group Safety Officer has been assigned by the Rescue Group. Prior to rescue operations, the Rescue Group will conduct a pre-rescue briefing to include the objectives of the rescue, the tactics, and identifying the safety measures in place.

The Edge person is the only person on the team that should be communicating to the Rescue Group. They are responsible for communication to the haul team and the rescuer at the victim. The Haul team must consist of at least three (3) members and are responsible for raising or lowering the victim and only listens to the edge person for the commands of: “Raise”, “Lower”, “Stop”, “Slack”, and “Tension”.

The Medical unit should be established early on and can rest with the EMS authority on scene but work under the rescue group supervisor. Ensure the Medical Group stays out of the Hot zone unless appropriately trained and equipped.

ROPE RESCUE

When considering utilizing rope and rope rescue techniques, considerations should begin at the anchor points that are available to perform the rescue. Dependent upon where the rope rescue is to take place, there are generally two types of anchor points to consider, Natural and Man Made.

Natural Anchor points consists of heavy thick tree trunks and large rocks and boulders. You must evaluate the condition of trees, rocks, and boulders before you use them. What is the rock sitting on? Is the tree dead or alive? Is it stable enough to apply the force of

a 3:1 raising system and a two-person load? When possible, use a high point directional such as a tripod to limit the rope damage and assist in edge transitions.

Figure 1 - Natural Anchor using rope as an Anchor Sling

Man-made anchor points consist of things such as a vehicle, a building's structural elements, and aerial ladder or tripod as a high point. When utilizing man made anchors, the rescue group supervisor and rigging team must evaluate the feasibility of the anchor.

When using a vehicle, ensure the keys to the ignition are given to the rescue group supervisor or the steering wheel is locked out and tagged, the wheels are chocked, the anchor is set up perpendicular to the vehicle when possible, and you are utilizing structural members of the vehicle.

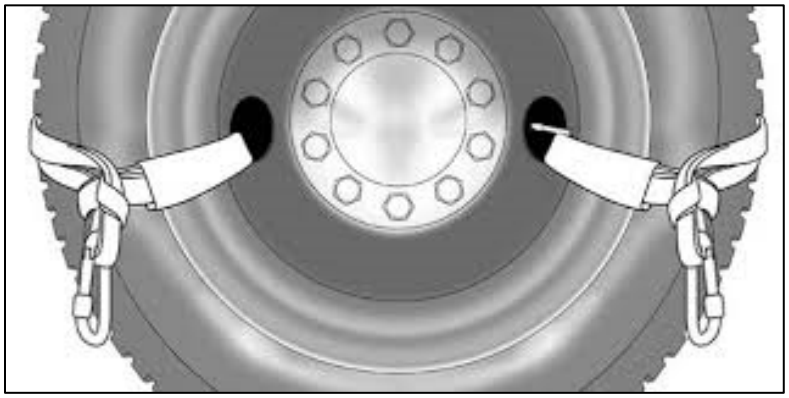

Figure 2 - Man Made Anchor using Apparatus Rear Dual

When using an aerial ladder as a high point directional or anchor, be aware of doubled and tripled loads due to mechanical advantage systems. Aerials must be at extension and angle to achieve a 1,000lbs load capacity before mechanical advantage systems can be attached. Ensure the haul line is in-line with the aerial at the tip to prevent side loading of the ladder.

A tripod, ladder jig, or A-frame can be used as artificial high points when the need to go below grade is a possibility. Ensuring that the high point is over the space you want to enter, and the resultant force is within the footprint of the high point is key to preventing injuries to the victim and rescuers.

Anchor software consists of webbing, rope as an anchor sling, and pre-manufactured webbing straps. When using webbing, there are two types of anchor slings that can be used: light anchors and general use anchors. Anytime you are using an anchor as part of a system, a general use anchor should be used. A general use anchor consists of a heavy anchor, webbing with at least two points of contact on the backside of the anchor and two points of contact on the system. Meaning doubled or tripled up webbing on a suitable anchor. Light use anchor is utilized for tying off the edge person and can be a single webbing sling such as a simple lark's foot.

Figure 3 - Manufactured Anchor Sling

Knots

(**IPE video 316.017 Basic Knots**)

Knots are the backbone of a rescue system. Systems cannot be built, rescuers cannot go over the side, and victims cannot be brought to safety without knots bringing it all

together. First, regardless of the knot you choose to tie to build the parts of the system you are working on, it must be dressed for optimal strength and recognition. The figure eight knot is the strongest and most versatile knot for rescue work. There are several knots in the figure eight family, but the most utilized is the figure eight on a bight. This knot forms a bight and allows the rigging team or rescuer to connect the rope into the system.

Figure 4 - On a Bight

For joining webbing together to form a sling, an overhand bend, also known as a water knot, is the best for joining two pieces of webbing together. Again, a knot when tied correctly and dressed has optimal strength and is easily recognized.

Figure 5 - Overhand Bend aka Water Knot

Rope systems

If knots are the backbone of a rope rescue system, then rope systems are the work horse. Rope systems are built to allow the haul team an easier time of raising or lowering a rescuer to the victim. The most basic system is a 1:1 system, in which a rope is attached to a rescuer and is raised or lowered with no mechanical advantage (MA). For every 1 foot of rope pulled, 1 foot of movement in received at the load. As the MA increases, the distance of travel by the load decreases. For a 300-pound load, 300 pounds of force must be applied to the system.

Figure 6 - 1:1 Mechanical Advantage

A 2:1 mechanical advantage system, also known as a ladder rig, is the easiest mechanical advantage system to set up as it uses a single pulley at the load and is raised with multiple members on the haul team. For every 2 foot of rope pulled, 1 foot of movement is received by the load. For a 300-pound load, 150 pounds of force must be applied to the system.

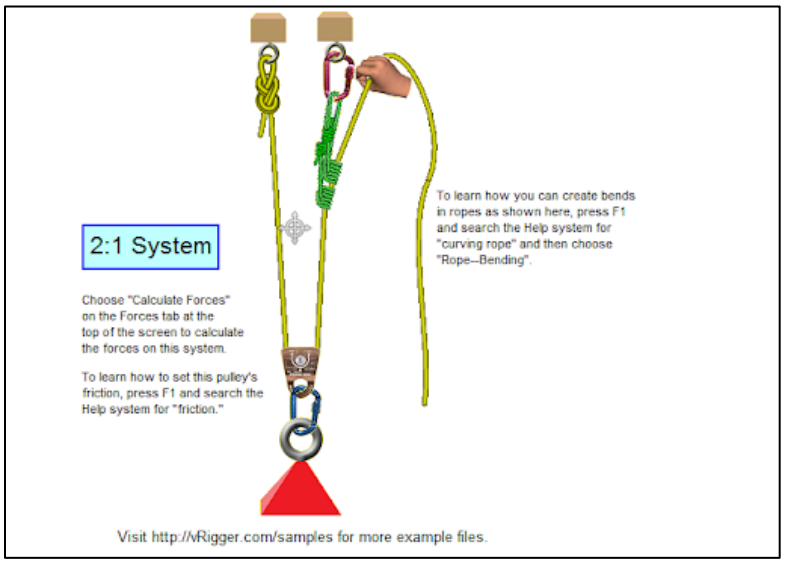

Figure 7 - 2:1 Mechanical Advantage

A 3:1 MA system, also known as a Z-Rig, is advantageous for use as an over the side system, especially if you do not have adequate personnel to use on a haul team. A zig rig is easy to rig, easy to identify, and is easy to add a progress capture to the load to stop the load from losing progress. In a 3:1 for every 3 foot of rope pulled, 1 foot of movement is received by the load. Ensuing that you have enough rope for the system is key to utilizing a 3:1. For a 300-pound load, 100 pounds of force must be applied to the system.

Figure 8 - 3:1 Mechanical Advantage aka Z-Rig

A 4:1 MA system, typically used in confined spaces on a high point, is great for use because it is compact size. In a 4:1 for every 4 foot of rope pulled, 1 foot of movement is received by the load. For a 300-pound load, 75 pounds of force must be applied to the system.

Figure 9 - 4:1 Mechanical Advantage

A safety line or a belay line is used whenever possible and should use a separate anchor and lifeline. The safety line is secured to the rescuer and victim on a separate attachment point from the main line. Safety lines should be provided with the use of a double prussic belay or other manufactured belay devices and tended with no slack allowed in the system. The primary use of a safety line is to catch the load if the main line fails and prevent any movement in the load.

When the occasion arises that a member needs to lower themselves without the use of a lowering system, the member should use a friction device such as a figure 8 plate or break bar rack. This operation should only be performed by a technician level trained member.

Figure 10 - Break Bar Rack

Figure 11 – Figure-8 Descending Device

Harnesses

The Fresno Fire Dept uses a Class III full body harness which is required for confined space entries and high angle rescues. A class II harness may be used for water and low angle rescues. Victim harnesses are designed for packaging victims into either the stokes or the system in a low angle rescue.

Figure 12 - Class III Harness

Figure 13 - Victim Harness

Communication systems

Solid communication in the rescue environment is key to a successful rescue operation. Voice communication is simplest and most reliable. When the need to communicate between the edge person and the haul team is over a large distance, radio communication is acceptable.

The edge person should be the only person communicating when the system is being utilized and a rescuer is over the side. The edge person will communicate with the haul team and the rescuer by name. One person from the haul team will communicate with the edge person to notify that a reset is needed.

Rope rescue command terminology consists solely of:

Slack - Slowly release rope until there is slack.

Tension - Slowly haul rope until there is no slack.

Raise - Smoothly begin taking up the rope.

Lower - Smoothly begin lowering the rope.

Stop - Safely stop all movement.

Utilizing an Aerial Apparatus in Rope Rescue

When an aerial is used to retrieve a packaged victim, it is considered a technical rescue. The Urban Search and Rescue (US&R) team shall be requested for all technical rescues to provide assistance as needed.

- If the situation requires a rescuer to escort the Stokes/packaged victim, the operation will be performed by the US&R team.

Do not exceed the rated load of the aerial ladder/tower when using the Stokes litter. Always reference the load chart provided with the aerial ladder for specific allowable loads.

Do not exceed the rated capacity of the rated attachment points; use them in pairs with the load centered.

All rigging shall be built to avoid entanglement.

All rigging shall be safety checked before moving a victim/Stokes litter (load).

A spotter shall maintain visual contact with the load and radio communication with the operator throughout the entire operation.

The spotter shall ensure the load does not become entangled with any object throughout the duration of the operation.

The aerial water way shall remain in the rescue position on a Ladder.

When using an aerial ladder, the ladder must be extended out far enough to avoid entanglement on the bed section, first fly section, or the aerial water way.

Throughout this evolution, use sound rigging practices such as locking all carabiners, so the locks rotate into the downward/locked position.

OPERATIONAL GUIDELINE

Aerial apparatus may function to move a packaged victim in multiple ways. The following operations listed from lowest to highest risk should be considered:

1. Movement of an ambulatory victim.
2. Aerial Tower mounted Stokes litter.
3. Short haul operation with either an Aerial Tower or an Aerial Ladder (Short haul with attendant, USAR operation only).
4. Stationary High point (USAR operation only).

Ambulatory Victims:

Aerial Towers should be considered the preferred method of moving an ambulatory victim at height. Once the victim is guided into the Aerial Tower, the victim should be secured using the ladder belt. If an aerial ladder is utilized, a member will assist the victim down the ladder. Ambulatory victims should be placed in a ladder belt and provided a helmet.

Aerial Tower-mounted Stokes Litter:

The use of the Aerial Tower's Stokes litter mounting arm is the safest of all the non-ambulatory operations and should be considered the first option for moving a packaged victim with an aerial apparatus. (See Figure 14)

Figure 14 - Stokes litter attached to the aerial tower

1. Secure the victim to the Stokes litter using victim harness and lashing.

2. Ensure the left side platform top rail is in the closed and locked position.

3. The rappelling arm assembly is to be positioned directly in front of the left side platform entrance gate. Lift up on the assembly and rotate 180 degrees. (See Figure 15) Ensure the arm assembly is locked before the Stokes litter is positioned on the arm.

Figure 15 - Rappelling arm deployed

4. Stainless steel overlays are provided on the rear handrail of the platform bucket as well as the top of the rappelling arm.

5. Position the Stokes litter on the rappelling arm and on the rear handrail of the platform.

6. Use the two attachment points on the inside of the platform bucket to secure the Stokes litter to the platform. Each attachment point accommodates two securing straps. (See Figure 16)

Figure 16 - Attachment Point for straps

7. Four (4) straps are provided.

    a. Two (2) of the straps have friction locks. (See Figure 17)

    b. Two (2) of the straps have ratchets. (See Figure 18)

8. Hold the Stokes litter in place until all the straps are secured to ensure it will not move.

Figure 17 - Friction lock strap

Figure 18 - Ratchet strap

9. Using one of the friction lock straps, loop the hook end around a hand hold (See Figure 19) on the Stokes litter (on the side closest to the attachment point) and secure the hook to the “D” ring on the strap.

Figure 19 - Friction lock strap around hand hold

10. Secure the latch to the slot of the corresponding upper attachment point. (See Figure 20)

Figure 20 - Secure latch in slot

a. Pull the free end of the strap to tighten.

11. For the opposite side (front/rear) using one of the friction lock straps, loop the hook end around a hand hold (See Figure 19) on the Stokes litter (on

the side closest to the attachment point) and secure the hook to the “D” ring on the strap.

a. Secure the latch to the slot of the corresponding upper attachment point. (See Figure 20 above.)

b. Pull the free end of the strap to tighten.

c. Repeat this process on the other attachment point.

d. Before moving the aerial tower platform, ensure the access door under the Stokes litter is latched closed. Once at ground level, loosen each of the straps and unhook from the Stokes litter. Remove the straps from the attachment points of the platform bucket and move to avoid a trip hazard.

e. Hold the Stokes litter until it has been removed from the platform.

f. Pass the Stokes litter to other firefighters on the ground.

Short-Haul Operation:

1. A short-haul operation may be performed with any aerial apparatus equipped with rated connection points. An Aerial Tower is stronger and more stable than an aerial ladder; therefore, it is considered the preferred resource. This operation uses a pre-made Stokes “Bridle” to connect the Stokes litter under the ladder from the rated attachment points. The use of a short-haul operation provides greater versatility than the mounted Stokes operation, but limitations exist:

    a. Victim must be in an area where the pre-made bridle will reach the Stokes litter and the rated attachment points on the aerial. Swinging is a risk factor for this operation; thus, the premade bridle is a designed length to reduce swing.

    b. The spotter may have difficulty maintaining visual contact with the load (victim/Stokes) throughout the entire operation and should maintain radio communication with the aerial operator. The spotter is to ensure the load does not become entangled with any object throughout the duration of the operation.

    c. The aerial apparatus must be spotted in an area where the length of the bridle will allow the victim to be placed in a safe area for removal.

Aerial operators should lift/move in a smooth manner, without causing the device or the load to bounce, jerk, or sway.

2. Tag lines should be used unless their use would create a greater hazard. Tag lines provide functional and safety purposes. Functionally, they help guide the load to the intended location. They provide safety by eliminating the potential for the load to swing and will help prevent the bridle or Stokes litter from becoming entangled with objects.

3. The following sections describe methods for using both the Aerial Tower and Aerial Ladder in a short haul operation to transport the Stokes and associated victim:

    a. Bridle Assembly: The bridle assembly consists of two (2) 10-foot pieces of rope with a figure eight on a bight tied into each end with carabiners attached to the figure eights. On one end, the bridle will be connected to the rated attachment points on the underside of the aerial. On the other end, it will be connected to the anchor plate of the Stokes Pre-Rig. (See Figures 23 and 24)

Aerial Tower Aerial Ladder

Figure 21 - Aerial Tower

Figure 22 - Straight ladder truck

1. Aerial Tower Operation

    - Spot and stabilize Aerial Tower according to FFD policies and incident needs.

    - Attach bridle carabiners directly to the rated attachment points on underside of the Tower platform, with carabiners oriented so the locks rotate into the downward/locked position, with the spine of the carabiner against the rubber stops under the Tower platform. (See Figure 23.)

Figure 23 - Attachments on tower

- Attach the Stokes pre-rig anchor plate to the bridle. (See Figure 24.)

Figure 24 - Stokes pre-rig to bridle

- Attach the Stokes pre-rig to the Stokes litter. (See Figure 25.)

Figure 25 - Stokes attached for short haul

- Secure the victim to the Stokes litter using victim lashing.

- Attach a tag line to the Stokes litter. The tag line can be constructed with one or two utility ropes, with a knot or carabiner as dictated by the incident needs. To a certain extent, the height at which this system hangs can be controlled by extending/retracting and raising/lowering the ladder, as this entire apparatus hangs approximately 10 feet from the bottom of the Tower platform.

2. Aerial Ladder Operation

- Spot and stabilize Aerial Ladder according to FFD policies and incident needs.

- When using an Aerial Ladder, the ladder must be extended out for the aerial water way. The aerial water way is to remain in the rescue position. When retracting the ladder ensure to avoid entanglement with the bed section, first fly section, or the aerial water way. (See Figure 26.)

Figure 26 Aerial Ladder short haul

- Attach bridle carabiners directly to the rated attachment points on the ladder with carabiners orientated so the locks rotate into the downward position. (See Figure 27.)

Figure 27 - Carabiners attached to aerial ladder

- Attach the Stokes pre-rig anchor plate to the bridle assembly. (See Figure 28)

Figure 28 - Stokes pre-rig to bridle

- Attach the Stokes pre-rig to the Stokes litter.
- Secure the victim to the Stokes litter using victim lashing.
- Attach a tag line to the Stokes litter. The tag line can be constructed with one or two utility ropes, as dictated by the incident needs. To a certain extent, the height at which this system hangs can be

controlled by extending/retracting and raising/lowering the ladder, as this entire apparatus hangs approximately 10 feet from the bottom of the ladder.

Stationary High Point:

The use of an aerial apparatus as a stationary high point is a technical skill. This evolution requires the use of skills such as deflective off sets and load redirects. This evolution is an advanced rope skill, which should only be carried out or overseen by members of the USAR Team.

DEFINITIONS

Aerial Tower: An aerial apparatus equipped with an elevating platform bucket, which is designed to support firefighting and rescue operations by positioning personnel, providing continuous egress, or discharging water at positions usually elevated from the ground.

Aerial Ladder: An aerial apparatus equipped with a power operated ladder, which allows firefighters to ascend and descend between the tip of the ladder and the turntable. As used by FFD, fully extended working height will be identified on the side of the ladder and in apparatus information book. Working height is measured from the ground to the highest ladder rung at maximum elevation and extension.

Bridle: The bridle assembly will be two (2) 10-foot pieces of rope with a figure eight on a bite tied into each end and carabiners attached to the figure eights. On one end, the bridle will be attached to the rated attachment points on the underside of the aerial. On the other end, it will be attached to the anchor plate of the stokes Pre-Rig.

Cold Zone: Area at a safe distance from the hazard and cannot quickly become hazardous.

Hot Zone: Area involving the victim, the most hazardous area.

Rope Rescue Communication:

Slack - Slowly release rope until there is slack.

Tension - Slowly haul rope until there is no slack.

Raise - Smoothly begin taking up the rope.

Lower - Smoothly begin lowering the rope.

Stop - Safely stop all movement.

Stokes Pre-Rig: Four-point connection set up for a Stokes litter attached to anchor plate. Load: Stokes, victim, and rigging.

Safety Check: After attachments are made and prior to any operational movement. Ensures all parts of the system are properly assembled, tied, and secured. Performed by a member who has not constructed that component.

Spotter: The purpose of the spotter is to assist the aerial operator in maneuvering the load into position and prevent entanglement and injury.

Vertical Environment: An emergency scene where a victim must be moved from above or below grade to a safe location.

Victim Lashing: The victim lashing consists of equipment used to secure a victim in a Stokes litter.

Warm Zone: Area which can potentially become hazardous and involve a rescuer or bystander.

REFERENCES

Standard Operating Procedures Manual

Section 202.014, Urban Search and Rescue (USAR)

Section 202.014b Hazard Mitigation

Section 202.014b, Rope Rescue

Training and Equipment Manual

Section 306.003, Basic Rope Rescue Equipment

Section 313.041, Standard Stabilizer Deploy

Section 313.042, Standard Aerial Deploy

National Fire Protection Association

NFPA 1670, Standard on Operations and Training for Technical Search and Rescue Incidents

NFPA 1006, Standard for Technical rescue Personnel Professional Qualifications

Smeal Fire Apparatus

SFA Aerial Platform Operations & Service Manual

SFA Aerial Ladder Operations & Service Manual