Ropes
Lesson One
Rescue Operations for Rope Rescue

DOMAIN: COGNITIVE

LEVEL OF LEARNING: COMPREHENSION

MATERIALS

IFSTA 7th edition Fire Service Search and Rescue Manual; IFSTA 5th edition Essentials of Firefighting; High Angle Rescue Techniques 3rd edition by Tom Vines and Steve Hudson, available from Mosby / Jems Publishers or Firehouse.com; NFPA 1006, Standard for Technical Rescuer Professional Qualifications; NFPA 1670, Standard on Operations and Training for Technical Rescue Incidents; NFPA 1561, Standard on Emergency Services Incident Management Systems 2008 edition, National Incident Management System. Laptop computer, multimedia projector; whiteboard or flipchart, and marker pens.

NFPA 1006, 2008 edition JPRs

6.1.1 Construct a multiple-point anchor system
6.1.2 Construct a compound rope mechanical advantage system
6.1.3 Construct a fixed rope system
6.1.4 Direct the operation of a compound rope mechanical advantage system
6.2.2 Move a victim in a high-angle or vertical environment
6.2.5 Direct a team in the construction of a high-line system
6.2.6 Direct a team in the operation of a high-line system

Junior Member Statement:

Junior Member training activities should be supervised by qualified instructors to assure that the cognitive and psychomotor skills are completed in a safe and non-evasive

manner. While it is critical that instructors be constantly aware of the capabilities of all students both mentally and physically to complete certain tasks safely and successfully, the instructor should take every opportunity to discuss with departmental leaders and students the maturity and job awareness each participant has for the hazards associated with fire and rescue training.

TERMINAL OBJECTIVE

The Technical Rescuer shall correctly identify in writing, the necessary elements of pre-incident planning, a scene size-up, incident action plan, and hazard assessment procedures, associated with rope rescue incidents.

ENABLING OBJECTIVES

1. The Technical Rescuer shall correctly describe in writing, the necessary elements of successful pre-planning as they relate to rope rescue incidents.

2. The Technical Rescuer shall correctly describe in writing, the factors that rescuers must know to effectively perform a scene size-up involving rope rescue incidents.

3. The Technical Rescuer shall correctly describe in writing, the types of hazards and their consequences for rescuers that need to be included in a hazards assessment associated with incidents involving rope rescue operations.

4. The Technical Rescuer shall correctly identify in writing various consensus standards related to rope rescue and how each standard addresses rope usage at fire and rescue incidents.

5. The Technical Rescuer candidate, given the appropriate equipment, shall correctly demonstrate the proper use of basic PPE and accessory gear and describe its purpose for rope rescue incidents.

6. The Technical Rescuer shall correctly describe, in writing, the function of software equipment including ropes used for rope rescue operations.

7. The Technical Rescuer shall correctly describe, in writing, the function of hardware equipment used for rope rescue operations.

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MOTIVATION

The instructor should cover the basic elements of site operations specific to the requirements of the Rope Rescue incident. Setting up and maintaining proper site operations for an incident involving rope rescue operations is extremely important. Safety of the personnel, patients, and even the equipment depends on managing the scene properly. When performed correctly, site operations will allow for a smooth and efficient rescue operation that will remain adaptable to the changing variables of a typical incident.

PRESENTATION

ENABLING OBJECTIVE #1

The Technical Rescuer shall correctly describe in writing, the necessary elements of successful pre-planning as they relate to rope rescue incidents.

1. Define and discuss a needs assessment and its components.
    a) Conduct a pre-incident site survey by visiting potential rope rescue sites within the jurisdiction; including commercial, industrial and residential multi-story complexes, farms, cell towers etc.
    b) Review call logs to determine the frequency of rope rescue operations at a given site.
    c) What is the severity and complication of past and potential rope rescue operations?
    d) What are the estimated response times to potential rope rescue locations?
    e) Obtain area guidebooks, aerial photos

f) Prepare hazard identification maps through geographic information systems (GIS).
g) Identify who will have jurisdictional and operational responsibility for rescue in a local area.
h) What personnel and equipment requirements are necessary for all risk locations?

Reference: High Angle Rescue Techniques 3rd edition page 166.

2. Discuss the reasons for conducting a thorough pre-incident site survey.
   a) It provides for a detailed evaluation of existing hazards at potential rope rescue locations.
   b) It examines previous locations where rope rescue operations were conducted and their associated situations.
   c) A pre-incident site survey aids in determining the frequency of, and potential for, rope rescue incidents occurring at specific locations.
   d) It allows for determination of the proper rope rescue PPE and equipment required for a given location and operation.

3. Discuss the importance of obtaining detailed contact information for each resource.
   a) Do these entities provide current information on present hazards?
   b) Do they provide information on any changes regarding their response capabilities?
   c) Are there any important changes for the TR? Are their Departments aware of thee changes?
   d) Are there procedures in place to receive updates and changes from other agencies that may affect your response effectiveness?

4. Discuss past and potential rope rescue incidents for the given jurisdiction and have the Technical Rescuers point out specific “site-survey problems” associated with each incident. Examples might include problems associated with:
   a) Industry.
   b) Structural Collapse.
   c) Cave-Ins.
   d) Elevated areas, bridges, and overpasses.

e) Confined Spaces.
f) Water hazards.
g) Elevators.
h) Special Rescue Situations such as Mine and Cave rescue.
i) Public Utilities.

Reference: IFSTA 7th edition Fire Service Search and Rescue, pages 7-17.
Reference: High Angle Rescue Techniques, 3rd edition, page 166.

5. Identify the various incident locations for the given jurisdiction, have the Technical Rescuers answer the following questions related to preparing a site-survey.
   a) Where have previous rope rescue operations occurred?
   b) What types of prior rope rescue / recovery operations have occurred?
   c) What is the frequency of rope rescues at any of the given locations?
   d) How technically complex have the rope rescues been?
   e) What obstacles have made rope rescue operations more difficult?
   f) What is the current response time for personnel and equipment, both local and mutual aid if required?
   g) Has the department been sufficiently equipped for these responses?
   h) Have rescue response personnel been adequately trained for these responses?
   i) Are there specialized rope rescue teams available for response?

6. Discuss operational aspects of a preplan.
   a) How are requests for emergency assistance handled?
   b) Who initiates an operational response for a rescue? Are backup resources and outside agencies alerted for assistance?
   c) How does the rope rescue team fit into the incident management, system and whom do they report to?
   d) What is the command structure on scene?

e) What is the communication setup including radio frequencies?
f) How medical control contacted and what are the medical protocols?
g) Are SOGs in place for carrying out a rope rescue mission?
h) Identify the procedures for establishing a landing zone, and identify known aerial and ground hazards associated with landing a helicopter.
i) How does the team conform to regulations and standards?
j) Are there guidelines established for conducting a recovery operation?

Reference: High Angle Rescue Techniques, 3rd edition, page166.

7. Identify and discuss the two important elements of evaluating a preplan.
   a) Review rescue tactics.
   b) Review training deficiencies.

8. Identify and discuss the 5 requirements that must be met for the two pre-plan elements.
   a) Inventory available equipment, human resources, and their skill levels.
   b) Strengthen joint operational responses through interagency training.
   c) Identifying sites with recurring incidents and train at those sites.
   d) Evaluate your team to decide if the rescue team is ready for potentially very difficult rescues.
   e) Prepare for worst case scenarios.

Reference: High Angle Rescue Techniques 3rd. edition page167.

9. Discuss communication guidelines for on scene rope rescue operations.
   a) Effective communication is critical to the coordination of the operation and safety of all rescuers.
   b) On scene conditions can play havoc with physical and electronic communication efforts.

c) Verbal commands may be blocked or misinterpreted by obstacle or high winds or distance.
d) Electronic communications may be disrupted by confined spaces, natural obstructions such as rock overhangs and intervening ridgelines.
e) Choosing a simplex system (car to car) over a repeater system may be more effective as long as line of site is maintained by the rescuers.
f) Procedures should be established that ensures effective on-scene communications especially when working with multiple agencies.
g) In most rope rescue operations the problem is not communicating, the problem is holding onto the radios. A solution to that problem is a radio chest harness.
h) Voice activated headsets are (VOX) are effective for short range communications but in tight spaces they may get hung up or pulled off the rescuer's head, and sometimes don't work well with many styles of helmets.
i) A bullhorn may be a good alternative as long as questions to the victim are short and concise, requiring the victim to answer only yes or no.
j) The victim may verbally answer or using a pre-arranged response signal using 1 arm lift or 1 flashlight click for YES and 2 arm lifts or 2 flashlight clicks for NO.

10. Discuss and demonstrate the acronym SUDOT as a suggestion for communicating with fellow rescuers using a whistleduring a raising or lowering operation.
a) S- STOP (1blast).
b) U- UP (2 blasts).
c) D- DOWN (3 blast).
d) O- OFF ROPE (4 blasts).
e) T- TROUBLE (1 continued long blast).

Reference: High Angle Rescue Techniques, 3rd edition, 173 through 174.

11. Discuss the purpose for NFPA 1670 Operations and Training for Technical Rescue Incidents, and how it may impact pre-incident planning and potential scene size-ups.

a) The document requires local jurisdictions to survey their response districts to assess the potential for various rescue incidents.
b) The Authority Having Jurisdiction (AHJ) shall make decisions regarding how to effectively respond and mitigate the problems associated with each rescue incident.

12. Point out that NFPA 1670, Section 2-2.1 requires the AHJ to develop procedures for the procurement and utilization of resources needed to conduct a safe and effective structural collapse rescue operation.
    a) The AHJ may choose to train and equip department personnel to meet all identified operational capabilities.
    b) The AHJ may choose to enter into mutual aid with neighboring entities.
    c) The AHJ may contract with private providers.
    d) The AHJ may choose a combination of the above.

13. Identify and discuss the departmental functions for the Awareness Level response to rope rescue incidents as established by NFPA 1670.
    a) Procedures should be established for conducting a scene size-up.
    b) Procedures should be established for the identification of the resources needed to conduct a safe operation.
    c) Procedures should be established for implementing the emergency response system.
    d) Procedures should be established for implementing site control and scene management.
    e) The department should recognize general hazards associated with rope rescue incidents and procedures for mitigating the hazards.
    f) Procedures for identifying and utilization of personal protective equipment assigned for use at a rope rescue incident.

14. Identify and discuss the departmental functions for the Operations Level response to rope rescue incidents.
    a) Implement procedures for selection, construction, and use of rope based mechanical advantage systems.

b) Implement procedures for establishing the need, selecting the proper equipment, and placing edge protection.
c) Implement procedures for the safe construction, and use of single point and multi-point anchor systems within the scope of the organization's training.
d) Implement procedures for selection, construction, and use of an appropriate belay system.
e) Implement procedures for the safe construction, and use of a lowering system within the scope of the organization's training.
f) Implement procedures properly tying any knots used by the rope rescue team.
g) Implement procedures for ensuring safety ay all rope rescue operations.
h) Implement procedures for appropriately packaging a patient in a litter.
i) Implement procedures for selection, use and maintenance of proper rope rescue equipment and rope rescue systems.
j) Implement procedures for the safe construction, and use of a raising system in the low angle environment.
k) Implement procedures for the safely ascending and descending a fixed line within the scope of the organization's training.
l) Implement procedures for using litter attendants in a low angle environment.

15. Identify and discuss the departmental functions for the Technician Level response to rope rescue incidents as established by NFPA 1670.
    a) Implement procedures for the safe construction and use of a load distributing anchor system.
    b) Implement procedures for the selection construction, and use of a highline rope system within the scope of the organizations training.
    c) Implement procedures for the selection construction, and use of a rope based raising system in a high angle environment within the scope of the organizations training.
    d) Implement procedures for passing a knot through rope rescue system.
    e) Implement procedures for litter attendants in a high angle environment.

Reference: NFPA 1670 Standard on Operations and Training for Technical Rescue Incidents.

16. Discuss how training integrates into the pre-planning process.
    a) Periodic intensive training should be made available to all personnel who may be involved in the incident.
    b) Training exercises give those who would be involved in an incident an opportunity to see the plan in action and test their understanding of the plan.
    c) Any deficiencies can be identified and remedied.

Reference: IFSTA 7th edition Fire Service Search and Rescue, page 195.

APPLICATION

Conduct a short class exercise. Have the Technical Rescuers demonstrate their ability to pre-plan a possible rope rescue operation using local county maps or one provided by the instructor and a simulated 911 call. Ask the Technical Rescuers to identify the correct responding department based on the 911 caller's directions. Have the Technical Rescuers pinpoint access and egress routes for rescue personnel allowing for a fast response and safe operation. Discuss City and County mutual aid that might be needed. Have the Technical Rescuers list the typical number of personnel, PPE, and equipment requirements for this rescue operation. If the location is an actual site where previous rope rescue operations have occurred, have the Technical Rescuers elaborate on what methods, equipment, and personnel were used in the past.

PRESENTATION

ENABLING OBJECTIVE #2

The Technical Rescuer shall correctly describe in writing, the factors that rescuers must know to effectively perform a scene size-up involving rope rescue incidents.

1. Provide a definition of scene size-up.
    a) Size-up attempts to identify the nature and severity of the rescue incident, factoring in the

type of rescue, number and location of victims, existing and potential on-scene hazards, confirms rescue versus recovery, and helps to verify resource needs.

b) Size-up is an on-going process of observation and evaluation of the rescue scene for needed changes in strategic goals and tactical considerations for that incident.

2. Discuss the components of a scene size-up?
   a) First arriving units begin the Initial assessment of the scene situation.
   b) The assessment is divided into two steps: primary and secondary assessment.
   c) During the initial scene size-up steps to take control of the scene are initiated.

3. Discuss the points to address for Phase One-Assessment on arrival of a rope rescue operation during a primary assessment for a rope rescue operation.
   a) Information gathering.
   b) Decision-making.
   c) Scene control such as establishing hot, warm and cold zones.
   d) Identify hazards that need to be mitigated.
   e) Determine what resources are immediately needed and evaluate future resource needs.

4. Define and discuss secondary assessment procedures for scene size-up, their components, and when they should be used.
   a) Is there an elevation difference? How much?
   b) What about hazard assessment?
   c) Identify the mode of operation, rescue or recovery.

5. Discuss the points to address for Phase Two-Pre-Rescue Operations of a rope rescue operation.
   a) Developing an incident action plan (IAP).
   b) Gathering the resource of personnel and equipment.
   c) Identify lighting needs.
   d) Identify and mitigate primary and secondary hazards.

e) Provide for fire protection when the situation dictates.
f) Provide for effective communications,

6. Identify and discuss the different roles within a rescue team.
   a) Team leader.
   b) Rescuer and Brake tender (belayer).
   c) Back-up team.
   d) Hauling team.

7. Discuss the points to address for Phase Three- Rescue Operations of a rope rescue operation.
   a) Implement an accountability system.
   b) Develop steps for reaching victims.
   c) Develop procedures for stabilizing and packaging a victim such as using different litters, litter slings, and harnesses in different situations.
   d) Develop procedures for gaining access to and rescuing the victims in a high and low angle environment and below grade environments.

8. Discuss the points to address for Phase Four- Termination of a rope rescue operation.
   a) Identifying and collecting equipment.
   b) Possible abandonment of equipment.
   c) Scene investigation.
   d) Release of control.
   e) Provide a Critical Incident Debriefing (CISD) for all participating personnel.

Reference: IFSTA 7th edition Fire Service Search and Rescue, pages 48 and 49, and 154.

9. Identify and discuss the importance of on-scene safety and survival priorities.
   a) Do not rush, maintain control.
   b) Choose well trained experienced personnel for the core of the team.
   c) Rescuers should be prepared for all emergency contingencies including self survival.
   d) Establish a well marked safety perimeter using chalk, crime scene or fire line tape, rope and chemical light sticks for night time operations.
   e) Make sure all rescuers are tied in when working within 10' of an unprotected edge.

f) Minimize the number of rescuers working close to an unprotected edge,
g) Designate an Incident Safety Officer (ISO).
h) Perform a safety check before and during the use of the rope rescue system.
i) Use simple communication terminology.
j) Make sure all personnel are using appropriate and functional PPE.
k) Create a redundant rescue system.
l) Never get on a rope without adequate gear to perform a rappel or ascension and a self-rescue.
m) Use edge protection.

Reference: High Angle Rescue Techniques, 3rd edition, page 175.

10. Discuss the need to perform a risk analysis of the operation.
    a) Rescue operations will require a greater degree of risk for rescuers because patient's lives are at risk. The time element is more critical in situations where savable lives are at risk. The operational pace of the rescue is faster and the likelihood of mistakes occurring increases.

PRESENTATION

ENABLING OBJECTIVE #3

The Technical Rescuer shall correctly describe in writing, the types of hazards and their consequences for rescuers that need to be included in a hazards assessment associated with incidents involving rope rescue operations.

1. Identify and discuss general hazards with rope rescue.
    a) Ineffective communications.
    b) "Weld abrasion" caused by nylon rubbing on aluminum.
    c) Misuse and inattention of equipment.
    d) Improperly tied rigging.
    e) Cross gate forces on carabiners.
    f) Unlocked carabiners, carabiner gates held open by webbing or obstacles.
    g) Failure to wear the appropriate PPE, especially a helmet.
    h) Poorly tensioned prussik.

i) Rescuer fatigue, thirst, boredom, distractions.

Reference: High Angle Rescue Techniques, 3rd edition, page 178.

2. Identify and discuss scene hazards.
   a) Elevated heights.
   b) Loose debris.
   c) Sharp edges and abrasive surfaces.
   d) Slippery surfaces.
   e) Downed power lines.
   f) Hazardous material leakage.
   g) Fire /explosion.
   h) Lack of suitable anchors.
   i) Adverse weather/darkness.

Reference: IFSTA 7th edition Fire Service Search and Rescue, page 141.

3. Discuss how through hazard assessment, these hazards can be minimized for the safety of the rescuers and patients.
   a) Include a discussion on scene control.
   b) Explain the idea of isolation / evacuation.
   c) Identify hazard control zones: hot, warm, cold.
   d) Ask why personnel accountability / patient accountability are important.
   e) Discuss the significance of entry permits for confined space rope rescue incidents.

Reference: IFSTA 7th edition Fire Service Search and Rescue, page 140.

4. Discuss the importance, for rescuer and bystander safety, of creating a hazard zone at a rope rescue incident.
   a) One popular model identifies three zones Hot, Warm, and Cold.
   b) The Hot Zone is the area where the rope rescue operation is taking place. The size will vary dependent on the nature and extent of the problem. Only personnel who are dealing directly with accessing, treating or freeing victims should be permitted into this area.

c) Warm Zones are located adjacent to the Hot Zone. This area is for support personnel assisting those in the Hot Zone and staged equipment.
d) Cold Zones surround the Hot and Warm Zones. The command post, PIO, incoming personnel, and equipment waiting for assignment are located in this zone. The outer boundary of this zone should be cordoned off to the public.

5. Identify and discuss other models are used throughout the rescue community.
   a) The AHJ should make the determination which model is most effective for the incident. Discuss what models are used by the AHJ.

Reference: IFSTA 7th edition Fire Service Search and Rescue Manual, pages 45 to 48, 146 and 147, 223 to 225, 417.

6. Emphasize the importance of determining the method of the rope rescue operation as soon as possible.
   a) How much time will it take to set up a rope rescue recovery system? The patient's condition is the determining factor.
   b) What equipment and PPE will be needed?
   c) Remember - Keep It Simple Sweetheart (KISS).
   d) Consider the Probability of Success (POS). Will the chosen strategy and tactics solve the problem?
   e) What are your on-scene resources? Are sufficient resources and personnel currently available to make strategies and tactics worked as planned?
   f) What are your off-scene resources? What additional time is required for any off-scene resources to respond?

7. Consider the risk to your rescue personnel. Point out that the primary concern is rescuer safety.

Reference: IFSTA 7th edition Fire Service Search and Rescue Manual, pages 27 to 32.

APPLICATION

Divide the class into groups and have available pictures of possible rescue sites for three rope rescue operations. Have the groups do a site-survey and a needs assessment for a possible response to each of the sites. If the groups have site-surveys that have already been completed for the AHJ; these can be used to enforce the types of hazards that are being looked for.

Using information from the site-surveys, needs assessments, and the same pictures with a hazard scenario, have the Technical Rescuers, working in the same teams, complete an initial scene size-up, hazards assessment and IAP for the scene. Emphasize to the Technical Rescuers that you want the assessment to include the level of training of personnel that will be involved and where they can contribute.

SCENARIOS SUGGESTIONS:

30 to 45 minutes for each scenario.

Rope Rescue Scenarios:

Mountain: A middle-aged couple has fallen from a mountain trail, approximately 100' down a steep rock incline that is partially covered in mountain laurel. Both are injured and the man is unconscious, they are unable to assist themselves. Date and Time of day: Oct. 28, 4:15 P.M., Weather: Current (Light Rain and Cool / 50 degrees F.), Forecast for next 12 hours: Continued Rain, May be heavy at times, Over-night low of 38 degrees F.

Water Tower: A 38 year-old painter has fallen and is hanging from a safety cord outside and below the walkway of an elevated water tank, approximately 90' from the ground. He is conscious but unable to move or feel his legs. Date and Time of day: July 10th, 2:30 P.M. Weather: Current (Clear / 95 degrees F.), Forecast for next 12 hours: Possible late afternoon thunderstorms.

Sloped Embankment: A charter bus has crashed through the highway guard rail and rolled several times down a steep slope (50 degree inline) and has come to rest 80' below the roadway, upside down in a small stream at the edge of dense woodland. There is a driver and 42 retired individuals on board with various injuries, some are critical and one

known fatality. Date and Time of day: February 5, 2:20 P.M. Weather: Current (Light Snow and Cold / 28 degrees F.), Forecast for next 12 hours: Continued Snow, Accumulation of 3" to 4" predicted, overnight low of 19 degrees F.

PRESENTATION

ENABLING OBJECTIVE #4

The Technical Rescuer shall correctly identify in writing various consensus standards related to rope rescue and how each standard addresses rope usage fire and rescue incidents.

1. Identify the purpose the ASTM International standard (formerly the American Society for Testing and Materials).
   a) An international organization that develops standards through a full consensus method.
   b) Standards that apply to the rope rescue environment include search and rescue, recreational climbing equipment, and arboriculture equipment.

2. Identify the purpose and discuss the NFPA 1983, Standard for Fire Service Life Safety Rope and System Components, classification criteria for using rescue rope for various rescue operations.
   a) This standard establishes minimum use guidelines for life safety rope, software equipment such as webbing, accessory cord, and all hardware like carabiners, and Rescue 8 descenders.
   b) Light-use lifeline - diameter is 3/8” (9.5mm) - 1/2” (13mm) with a breaking strength of 4500 pounds and a maximum safe working load of 300 pounds.
   c) General-use lifeline - diameter is 1/2"(13mm)-not more than 5/8” (16mm) with a breaking strength of 9000 pounds and a maximum safe working load of 600 pounds.
   d) Escape rope - diameter is 1 9/64” (7.5mm) – less than 3/8” (9.5mm) with a minimum breaking strength of 3000 pounds and a maximum safe working load of 300 pounds (intended only for emergency self-rescue situations).

e) Throw line - diameter criteria is the same as escape rope with a minimum breaking strength of 3000 pounds.

Reference: NFPA 1983, Standard on Fire Service Life Safety Rope and System Components.

3. Identify the purpose of NFPA 1951, Standard on Protective Ensemble for Urban Search and Rescue Operations.
   a) It establishes minimum guidelines for clothing, helmets, gloves and footwear for urban search and rescue activity.

Reference: High Angle Rescue Techniques, 3rd edition, page 10.

PRESENTATION

ENABLING OBJECTIVE #5

The Technical Rescuer candidate, given the appropriate equipment, shall correctly demonstrate the proper use of basic PPE and accessory gear and describe its purpose for rope rescue incidents.

1. Point out that when conducting a risk analysis of any rope rescue incident, the importance of specialized PPE must be stressed. Rescuer safety is essential and rescuer comfort is a must.

2. Describe the general guidelines established in NFPA 1951 for the use of helmets in a rope rescue environment.
   a) Helmets worn in high angle rescue should be designed to withstand the rigors o the environment.
   b) A narrow brim and a non-stretch chin strap are essential.
   c) The chin strap should have three non-stretch suspension points, one on each side of the helmet, and one in the rear.
   d) Materials used for rescue helmets include plastic,
   e) Fiberglass and Kevlar composites.
   f) The shell should be rigid enough to withstand impact and penetration by sharp objects.

g) The inside suspension should keep the shell from touching the skull.
h) Construction helmets and motorcycle helmets do not make good rescue helmets.
i) Fire helmets tend to be cumbersome in the high angle environment.

3. Discuss the general performance criteria for outerwear.
   a) Outerwear must fit snugly in order to reduce the likelihood of entanglement in the rope system, but must be loose enough to allow for optimum body movement.
   b) Must be tough enough to resist tearing and abrasion damage.
   c) Having a waterproof outer shell that has wicking capabilities is critical for protecting the rescuers from perspiration, wind and rain.
   d) A criterion for selecting the appropriate waterproof material is if you can stand under a shower for 1/2 hour without getting soaked through.
   e) An insulating layer of clothing should be worn under the waterproof shell.
   f) Cotton is the least desirable fabric in wet and cold environments.
   g) Wool is the traditional choice of fabric chosen for maximum warmth.
   h) Polyester pile is another fabric that provides comfort and warmth when in contact with the skin.
   i) Neither wool nor polyester pile provides adequate protection from the wind, so an outer shell must be worn.
   j) Polypropylene or a polypropylene blend has become the material of choice for underwear when participating in outdoor activities.
   k) Underwear made of flammable material may not be suited for personnel working in helicopters or other environments subject to flash fires.

4. Emphasize the fact that structural firefighting gear is seldom appropriate for rope rescue operations.
   a) Structural Fire Fighting PPE would only be used when the operation will place rescuers in close proximity to fire or potential fire and in extremely cold or wet environments.

5. Discuss the general performance criteria for footwear.

a) Criteria include comfort, protection, and adhesion.
b) Leather composition affords the best qualities needed for a rescue boot.
c) Boots should provide support to the ankles and protect the feet from penetrating injuries.
d) The boot sole should have a reasonable amount of adhesive quality.
e) A good choice of socks is important for warmth, comfort and prevention of blisters.
f) A two-sock combination consisting of a lightweight inner polypropylene sock that reduces friction on the skin, and a thick wool outer sock that increases warmth, and provides good comfort.

6. Discuss the general performance criteria for gloves.
   a) Criteria include comfort, protection, and adhesion.
   b) Leather composition affords the best qualities needed for a glove.
   c) Deerskin or goatskin offers the best protection.
   d) Gloves should shield the hand and prevent discomfort.
   e) Commercial gloves with reinforced palms are available for purchase.

Reference: IFSTA Fire Service Search and Rescue, 7th edition pages 54 through 58

7. Discuss the characteristics of the Class I rescue harness.
   a) It is designed for emergency escape use only.
   b) The harness is designed for one time use.
   c) It has a minimum breaking strength of 4500 lbs. and a design load of 300 lbf (1.33 k/n).
   d) It looks like a Class II rescue harness in design but rated only for a one-person load.
   e) It fastens around the waist and thighs or under the buttocks.

8. Discuss the characteristics of the Class II rescue harness.
   a) It is designed for rescue operations
   b) The harness has a minimum breaking strength of 9000 lbs. and a design load is 600lbf.
   c) It is rated as a two-person load rescue harness.

d) The harness fastens around the waist and thighs, or under the buttocks.

9. Discuss the characteristics of the Class III rescue harness.
   a) It is designed for fall protection and rescue operations where the potential for inversion may occur.
   b) It has a minimum breaking strength of 9000 lbs. a design load is 600lbf
   c) The harness is rated as a two-person load rescue harness.
   d) It fastens around the waist and thighs or under the buttocks and over the shoulders.

10. Identify the minimum guidelines for webbing to be used as improvised rescue harnesses for humans.
   a) The webbing should be a minimum of 1 3/4" wide.
   b) The breaking strength should be 6000 lbs with a design load of 600 lbf.

11. Discuss the characteristics and design of modified harnesses:
   a) Rescue knot.
   b) Seat harness.
   c) Seat harness with chest harness.

12. Identify and discuss the safety checks that should be conducted for rescue harnesses.
   a) Check Class I, II, and III rescue harness straps and buckles.
   b) Check for frayed stitching and damaged metal.
   c) Follow the manufacturer’s guidelines for use, inspection, and maintenance.

13. Discuss the pathology of harness suspension.
   a) Serious problems can occur when rescuers suspend motionless for a long period of time. The compression created by the straps reduces the venous flow to the legs.
   b) This reduction in flow also affects the right side of the heart that causes reduction in overall cardiac output. This pathology can result in unconsciousness or death.
   c) A potential medical consequence of harness suspension is crush syndrome that can lead to renal failure and other life threatening conditions.

d) This pathology can be minimized greatly by using wide material for harnesses such 1 3/4" as recommended by NFPA 1983.

Reference: IFSTA 7th edition Fire Service Search and Rescue, pages 115 through 120.
Reference: High Angle rescue Techniques, 3rd edition, pages 13 through 16.

APPLICATION

Lay out the various types of PPE typically used by the respective jurisdiction. Have the Technical Rescuers identify known local rope rescue locations and provide pictures of these locations if possible. Have the students identify which PPE and equipment is best suited for rescue operations.

PRESENTATION

ENABLING OBJECTIVE #6

The Technical Rescuer shall correctly describe, in writing, the function of software equipment including ropes used for rope rescue operations.

1. Discuss the characteristics of laid rope, plaited rope, braided rope, and kernmantle rope.

2. Point out that NFPA 1983 recommends a safety factor of 15:1 for ropes used to support human beings.

3. Emphasize that the exterior of braided rope to the untrained eye, can be mistaken for kernmantle rope. These ropes are not designed for life loads but for utility applications.

Reference: IFSTA Fire Service Search and Rescue, 7th edition, pages 108 through 110.
Reference: High Angle Rescue Techniques, 3rd edition, pages 20 through 26.

4. Discuss guidelines for selecting the proper rescue rope.
   a) NFPA 1983 has established guidelines for the selection based on tensile strength and design loads (safe working load, SWL).

b) For light load operations, the tensile strength of the rope shall be no less than 4500 pounds, using a safety factor ratio of 15:1. The design load is calculated not to exceed 300 pounds.
c) For general rescue load operations, the tensile strength of the rope shall be no less than 9000 pounds, using a safety factor ratio of 15:1, the design load is calculated not to exceed 600 pounds.

Reference: High Angle Rescue Techniques, 3rd edition, page27.

5. Discuss the safety factor of rope rescue systems.
   a) The most realistic way to determine the needed tensile strength for a rescue operation is to calculate the load ratio of the system safety factor.
   b) The system safety factor estimates conditions that may be encountered in a high angle environment plus a realistic safety margin.
   c) To determine the system safety factor, all elements of the system must be analyzed including breaking strengths of various components, the way each component affects each other, and how the load will be applied. Then add a margin to cover unexpected forces that may be exerted on the system.
   d) The rescuers must be familiar with manufacturers breaking strength (MBS) of each component used in the system, also known as the component load ratio (CLR). The rescuer must know the CLR of each component within the system. Example: a 9,000lbf general purpose rescue rope loaded with a 300lbs rescuer would yield a 30:1 CLR (9,000 divided 300). If the expected load changes so does the CLR 9,000 divided by 400lbs would equal a 22.5 CLR.
   e) The rescuer must also know the ratio of the expected load on the system to the expected failure point of the weakest point in the system also known as the system load ratio (SLR).
   f) The rescuer must know both the CLR and the SLR in order to accurately determine the system safety factor. To calculate the SLR, the strength of the anchor would have to known. Example: a

9000 lbf general purpose rescue rope attached to a tested 5,100lbf anchor bolt would yield an SLR of 17:1 or 5,100lbf divided by 300lbs rescuer load.

g) Also factored in is the knot strength of the knot used to anchor the rope.

h) Most knots used for rescue come from the family of 8s, which have a strength reduction under load of 15% - 30%.

i) At 85% efficiency (15% knot strength reduction), the strength of the rope would be 7650lbf and the SLR would be 22:1 or 7,650lbf divided by 300lbs rescuer load.

j) If 2 rescuers exerting 600lbs is placed in the system, the SLR, using the above rope strength, would be approximately 11:1 or 7,650lbf divided by 600lbs rescuer load.

6. Point out that other factors to consider are shock loading, pulleys, edge friction, and the application of prussik, cams and other hardware.

7. Emphasize that most mountain rescue teams accept a minimum SLR of 10:1.

Reference: High Angle Rescue Techniques, 3rd edition, pages 27 through 28,

8. Discuss the role of the fall factor formula for dynamic rope.
   a) The fall factor is calculated by dividing the distance a rescuer may fall by the length of rope being used. If a rescuer climbed 100' to the anchor point the rope was attached to then fell the 100', the fall factor would be 1.
   b) As the fall factor increases, the severity of potential injury or fatality increases.
   c) This formula is based on a free fall descent.
   d) All attempts should be made to minimize the fall factor for rescue operations to less than 1.
   e) If the rope is running through multiple anchor points or the rope rubs against obstacles or get jammed during the fall, the ability of the rope to absorb energy would decrease thus increasing the potential fall factor.

9. Discuss the role of the fall factor formula for static rope.

a) For short lengths of static rope the forces are slightly less than predicted using the dynamic rope fall factor.
b) When applying the fall factor to a long piece of static rope, or to loads greater than a one person load, the force tends to be under estimated.
c) A 0.25 fall factor on a 5' piece of static rope would have a higher impact force than the same fall factor on a 2' piece static rope.

Reference: High Angle Rescue Techniques, 3rd edition, pages 22 through 23.

10. Discuss the criteria for using webbing in various rescue environments.
    a) Most webbing is constructed of nylon and comes in two forms; flat and tubular and ranges in size from one inch to two inches.
    b) One inch tubular has a breaking strength of 4000 pounds. One inch flat webbing has a breaking strength of 6000 pounds. Both are used to form anchor slings.
    c) NFPA 1983 recommends that any webbing that makes contact with a body shall be at 1 3/4" width with a breaking strength of 6000 pounds.

11. Discuss the criteria for using accessory cord.
    a) It is constructed of synthetic fiber and ranges in size from 6 - 8mm, and is used to construct prussik slings.
    b) Prussik slings are formed using a length of accessory cord tied with a Double Fisherman knot.
    c) A generally accepted rule is the prussik cord should be 2/3 to 3/4 the diameter of the mainline rope. For a 7/16" mainline rope an 8mm prussik cord would be suitable. For a 1/2" mainline rope a 9mm prussik cord would be suitable.
    d) Some training entities recommended 7mm as a minimum diameter for use during rescue operations.

Reference IFSTA Fire Service Search and Rescue 7th edition page 110
Reference: High Angle Rescue Techniques, 3rd edition, pages 29 through 30.

PRESENTATION

ENABLING OBJECTIVE #7

The Technical Rescuer shall correctly describe, in writing, the function of hardware equipment used for rope rescue operations.

1. Discuss the design, use, and safety considerations of Carabiners.
   a) They are made from hollow and solid aluminum alloy, solid steel, and stainless steel.
   b) The basic parts of a carabiner include the spine, gate, latch, and hinge.
   c) Carabiner shapes include oval, D-shaped, Modified D shape, and the HMS (pear shaped).
   d) The latching mechanism may be a pin and slot design, a claw (on gate) and slot design or a keyhole design.
   e) Carabiners designated for light use shall have a minimum major axis breaking strength, with gate closed, of 6000 pounds.
   f) Carabiners designated for general use shall have a minimum major axis breaking strength, with gate closed, of 9000 pounds.
   g) NFPA 1983 certified carabiners will have a “P” for personal use (1995-2001), an “L” for light duty use (2001), or a “G” for general duty use (1995-2001), and the tensile strength stamped on the carabiners.

2. Point out that when attaching carabiners to a vertical hauling system the gate of the carabiner should point down to reduce the chance of the gate unlocking as a result of vibration.

3. Point out that when attaching carabiners to a horizontal hauling system the gate of the carabiner should point towards the load to reduce the chance of the gate unlocking as a result of vibration.

4. Explain that tri-links and semi-circle design links are non-hinged screw links recommended for multi-directional loads.

5. Point out the need to inspect carabiners for wear grooves, deep gouges, sticking gate, or hinges and rust.
    a) Dropping carabiners, particularly aluminum, onto a hard surface may result in damage.
    b) Lubricate hinges and gate knurls with WD-40 or equivalent and wipe off excess.

Reference: IFSTA 7th edition Fire Service Search and Rescue, pages 120 through 122.
Reference: High Angle Rescue Techniques, 3rd edition, pages 48 through 56.

6. Discuss the design, use, and safety considerations of Rescue rings.
    a) Steel rings are used for various load-bearing applications.
    b) They are rated also as a multi-directional anchor.

7. Discuss the design, use, and safety considerations of swivels.
    a) They are applied at the anchor attachment point.
    b) They must be rated for life safety loads.
    c) Swivels prevent ropes in a mechanical advantage system from twisting, reducing the friction created by ropes rubbing on each other.

8. Discuss the design, use, and safety considerations of rope ascenders.
    a) There are cams such as the Gibbs and Rock Exotica, used for single load ascensions and hauling systems.
    b) They are not for arresting dynamic falls.
    c) There are free running cams activate only when a load is applied to the opposite end of the lever.
    d) There are spring-loaded cams that maintain light contact with the rope at all times, regardless whether or not a load is applied.
    e) There are handled ascenders teeth. They are designed for light use loads personal use ascensions only. Do no use for hauling life loads. They can be used for hauling equipment.

9. When using commercial rope grab devices, follow manufacturer guidelines and safety precautions when

incorporating these devices into a mechanical advantage system.

10. Verify whether or not the device is designed for use in a mechanical advantage system, and identify the limitations of use.

11. Discuss the design, use, and safety considerations of Figure 8 plates.
    a) They are designed as a double ring unit made of steel or anodized aluminum.
    b) They are used primarily as a descending device for rappelling.
    c) Figure 8 plates with appendages or ears on larger rings are commonly called Rescue 8s. The ears prevent the rope from slipping out of place and forming a girth hitch.
    d) The Rescue 8s will easily accommodate up to a 5/8" single rope or a 2 - 7/16" ropes.

12. Discuss the design, use, and safety considerations of rappel racks.
    a) They are commonly referred to as a brake bar rack.
    b) It is an elongated “U’ shaped steel rod with an eye on one side and a threaded nut on the other side. Across the rod are six friction bars.
    c) They are used as a rappelling device or a load control descending device.
    d) Friction can be changed under load by adding or subtracting friction bars. Figure 8 racks do not have this capability.
    e) Many rope rescue manuals recommend this devise when the need for adjusting a load is possible and when the descent exceeds 100' because it creates less friction.

13. Emphasize that when locking off the brake bar; do not allow the running end to be captured under the guide bar.

14. Discuss the design, use, and safety considerations of brake tubes.
    a) It is a large aluminum alloy tube with a right angle vertical post and a screw locking gate, designed to function as an oversized friction device, rope is

wrapped around the tube 3 - 4 times and can accommodate single or double ropes and has the capability of passing a knot.

15. Discuss the design, use, and safety considerations of pulleys.
    a) They are used to reduce rope friction, to reposition a rope to a safe area and or change the direction of a running rope.
    b) The sheave (wheel) should have a diameter of 4 times the diameter of the rope being used.
    c) Side plates should be able to open so pulley can be placed anywhere on the rope.

16. Discuss the design, use, and safety considerations of edge protectors.
    a) They reduce friction created by the rope going over the edge.
    b) They protect rope from abrasion, cuts and snags.

Reference: IFSTA 7th edition Fire Service Search and Rescue, pages 127.

APPLICATION

Divide the Technical Rescuers into equal size groups. Create 3 skill stations.

1. Identification and application of software used by the AHJ for rope rescue operations.
2. Identification and application of hardware used by the AHJ for rope rescue operations.
3. Set up a simple rope system and have each candidate calculate the SLR for the system.

Rotate each group through the stations and evaluate proficiency. Identify and correct mistakes

SUMMARY

Operations for rope rescue incidents involve several key elements that if addressed adequately will provide for a smooth, safe, and efficient operation. These elements include pre-incident planning, a scene size-up, incident action plans, and hazard assessment procedures. The rope rescue discipline covers different types of operations,

strategies and tactics specific to the various situations and locations encountered. Technical Rescuers must be able to perform all of the necessary site operation's elements at any rope rescue incident. The continual review and updating of these elements before, during, and after an event is imperative to the success of any operation. It should be noted that elements of rope rescue are commonly used in almost all of the other rescue disciplines. Therefore it becomes a key component in the Technical Rescuer's foundation of knowledge.