Technical Rescuer
Lesson One
Rescue Equipment

DOMAIN: COGNITIVE / PSYCHOMOTOR

LEVEL OF LEARNING: COMPREHENSION / APPLICATION

MATERIALS

Fire Service Search and Rescue, 7th Edition; IFSTA 5th Edition, Essentials of Firefighting; J&B Fire Fighter Skills 3rd Edition; J&B Fundamentals of Technical Rescue; NFPA 1006, Standard for Technical Rescuer Professional Qualifications; NFPA 1670, Standard on Operations and Training for Technical Rescue Incidents. Have available the various powered and non-powered (hand-operated) rescue equipment including generators and lighting equipment used by the AHJ (Authority Having Jurisdiction). Laptop computer; multimedia projector; whiteboard or flipchart; and marker pens.

NFPA 1006, 2013 Edition JPRs

5.2.1 Identify the needed support resources
5.2.2 Size up a rescue incident
5.2.3 Manage incident hazards
5.2.4 Manage resources in a rescue incident
5.2.5 Conduct a search
5.3.1 Victim Triage
5.4.2 Inspect and maintain rescue equipment

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 candidate shall correctly identify various types of rescue equipment and describe or demonstrate its function for various rescue incidents.

ENABLING OBJECTIVES

1. The Technical Rescuer candidate shall correctly describe or demonstrate the basic non-powered (hand operated) rescue equipment associated with incidents involving the different rescue environments.

2. The Technical Rescuer candidate shall correctly describe or demonstrate the use of basic powered rescue equipment associated with incidents involving the different rescue environments.

3. The Technical Rescuer candidate shall correctly describe and demonstrate the techniques for inspecting, servicing and maintaining rescue apparatus, equipment and tools used for various rescue disciplines.

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

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

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

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MOTIVATION

Rescue skills and techniques have changed very little over the years. However, rescue equipment seems to evolve every day. The development of newer and lighter equipment is making rescue operations easier and safer. Each of us must spend time evaluating and using our equipment so that we can rapidly adapt to a particular emergency scene.

PRESENTATION

ENABLING OBJECTIVE #1

The Technical Rescuer shall correctly describe or demonstrate the use of basic non-powered (hand operated) rescue equipment associated with incidents involving the different rescue environments.

1. Start this discussion by listing all the rescue disciplines. Then have the class identify the non-powered (hand operated) rescue equipment that may be needed for an incident involving each discipline and discuss each one.

2. Make note of the various equipment that is used in most or all of the rescue disciplines such as ropes, a knife, and a flashlight.

3. Discuss the different types of extinguishers and the agents used in each one.

4. Discuss the difference between dry chemical and dry powder agents, and the classes of fire for which each agent is used.

5. Demonstrate common rescue equipment.

a) Striking tools such as an axe, battering ram, sledge hammer, mallet, and punch.
b) Prying tools such as a pry-axe, Halligan bar, spanner wrench, and Kelly Bar.
c) Chopping tools such as flat-head axes and pick-axes.
d) Snipping tools such as side cutters and cable cutters.
e) Handsaws such as carpenter's saw, hacksaw, coping saw, and keyhole saws.
f) Knives such as pocket, seatbelt (V-saw), linoleum, and razor knives.
g) Pulling tools such as tripods, winches, and come-a-longs.
h) Chains such as alloy steel.
i) Jacks such as bar screw jacks, trench screw jacks, and ratchet lever jacks.
j) Cribbing – be aware of large knots found in wooden cribbing blocks as they can affect the strength of the block.

6. Point out what each of these tools is used for, and discuss how they have been designed to accomplish specific tasks?

Reference: Fire Service Search and Rescue, 7th Edition, pages 72 through 76, 84 through 87, 93 and 94, and 213 through 215, and 303.

PRESENTATION

ENABLING OBJECTIVE #2

The Technical Rescuer candidate shall correctly describe or demonstrate the use of basic powered rescue equipment associated with incidents involving the different rescue environments.

1. Start this discussion by listing all the rescue disciplines. Then have the class identify the powered rescue equipment that may be needed for an incident involving each discipline and discuss each one.

2. Identify the various types of hydraulic powered equipment that may be used for various rescue incidents. Briefly discuss their capabilities, safety rules,

and point out the different rescue environments that require the use of these tools.
   a) Spreaders.
   b) Shears.
   c) Combination spreader/shears.
   d) Extension rams.
   e) Porta-power tools.
   f) Hydraulic jacks.

3. Identify the various types of pneumatic (air) powered tools. Briefly discuss their capabilities and safety rules.
   a) Air chisels.
   b) Pneumatic nail guns.
   c) Air compressors.

4. Discuss air bags and their safety rules.
   a) Plan the lifting operation.
   b) Be familiar with equipment.
   c) Follow manufacturer's guidelines.
   d) Position bags on solid surface.
   e) Support load with cribbing.
   f) Prevent bags from coming into contact with temperatures of 220° F.
   g) When stacking bags follow the manufacturer's guidelines.

Reference: Fire Service Search and Rescue, 7th Edition, pages 81 and 81, and 87 through 90.

5. Identify the various types of power saws. Briefly discuss their capabilities and safety rules.
   a) Whizzer saw – can cut case harden locks and steel up to ¾ inches in diameter.
   b) Circular saw.
   c) Reciprocating saw.
   d) Chain saw.
   e) Wear appropriate PPE.
   f) Operate saws within their design limits.
   g) Use blades designed for the specific saw.
   h) Keep blade guards intact.
   i) Do not operate saw in a flammable/explosive atmosphere.
   j) Follow manufacturer guidelines.
   k) Protect the patient and rescuer from flying sparks and debris.

Reference: Fire Service Search and Rescue, 7th Edition,

pages 81 through 84.

NOTE: OSHA requires the use of helmets, safety glasses, hearing protection and chaps when operating a chain saw.

6. Identify the various types of cutting and burning equipment. Discuss their capabilities and hazards.
   a) Oxyacetylene.
   b) MAPP gas.
   c) Exothermic torch.
   d) Petrogen torch.
   e) Plasma cutter.
   f) Propane torch.

Reference: Fire Service Search and Rescue, 7th Edition, pages 90 through 92.

7. If used by the AHJ, give a brief demonstration of some of the specialized tools such as a thermal imaging camera, pneumatic shoring devices, and nail guns.

8. Identify the various types of power-generating and lighting equipment. Discuss their capabilities and safety rules.
   a) Power plants such as inverters and generators. Can convert a vehicles 12 or 24 volt DC current to 110 or 220 volts of AC current.
   b) Lighting equipment such as fixed lights and portable lights.
   c) Auxiliary lighting equipment such as electrical cables, extension cords, twist lock receptacles, and junction boxes.
   d) Ventilation equipment.

Reference: Fire Service Search and Rescue, 7th Edition, pages 69 through 71.

9. Emphasize the advantages each piece of equipment can afford to the rescuer. Base the advantages on speed, efficiency, and increased safety.

10. Show and discuss some manufacturer's recommended guidelines on the use of equipment used commonly in the jurisdiction in which you are teaching.

11. After the classroom discussion, give the candidates hands on instruction with various pieces of available equipment used by the AHJ.

12. Go over the equipment carefully to explain its operation and safety guidelines.

13. Demonstrate first, and then have each student operate the various pieces of equipment while wearing the proper PPE and following safety guidelines.

Reference: IFSTA 5th Edition Essentials of Firefighting, pages 330 through 346.

APPLICATION

Make arrangements to have a rescue truck available for show and tell of equipment.

PRESENTATION

ENABLING OBJECTIVE #3

The Technical Rescuer candidate shall correctly describe and demonstrate the techniques for inspecting, servicing, and maintaining rescue apparatus, equipment, and tools used for various rescue disciplines.

1. Discuss the importance of proper maintenance of all types of rescue apparatus, equipment, and tools.

2. Discuss the importance of developing proper SOGs for maintaining all types of rescue apparatus, equipment, and tools.

3. Discuss the importance of proper record keeping for maintaining all types of rescue apparatus, equipment, and tools.

4. Discuss the different types of inspections that are required for rescue service apparatus.
   a) Battery check.
   b) Braking systems.
   c) Coolant system.
   d) Electrical system.
   e) Fuel.

f) Hydraulic fluids.
g) Lubrication.
h) Oil.
i) Tire care.
j) Steering system.
k) Belts.
l) Tools, appliances, and equipment.

5. Point out that in order to perform certain apparatus component inspections for the verification of operational capability, appropriate testing equipment may be required. Consult the manufacturer's maintenance manuals to determine the appropriate test instruments and test parameters.

Reference: Fire Service Search and Rescue, 7th Edition, pages 62 through 66.
Reference: IFSTA 2nd Edition, Fire Department Pumping Apparatus, pages 192-194.
Reference: NFPA 1002 Standard for Driver/Operator, page 5.
Reference: Manufacturer's Operation and Maintenance manuals.

6. Briefly discuss the need for proper record keeping and reporting procedures to maintain the correct documentation for an apparatus.
   a) Recording procedures.
   b) Reporting procedures.

7. Discuss the purpose for having a preventative maintenance record keeping system for apparatus and equipment.
   a) Safety.
   b) Reliability.
   c) Assessment of functional capability.
   d) Operator confidence.
   e) Budgeting analysis.
   f) Assessment of apparatus and equipment longevity.
   g) Prediction of future departmental apparatus and equipment requirements.

8. Discuss the various types of inspection/maintenance records that may be required for any type of rescue apparatus.

a) Time-frequency record keeping: daily, weekly, and periodic records.
b) Component replacement records due to mechanical failure of a part.

Reference: IFSTA 7th Edition, Fire Department Pumping Apparatus, pages 192-193.

9. Discuss the engine lubrication system of an available rescue apparatus from the AHJ.
   a) Engine oil.
   b) Oil filters.
   c) Oil pumps.

10. Discuss the engine air induction system of an available rescue apparatus from the AHJ.
   a) Cartridge type filters.
   b) Oil bath type.

11. Discuss the fuel system and its individual components with regard to an available rescue apparatus from the AHJ.
   a) Fuel filters.
   b) Fuel lines.
   c) Fuel tank.
   d) Fuel pumps, electrical, and mechanical.

12. Discuss the engine cooling system components of an available rescue apparatus from the AHJ.
   a) Radiators.
   b) Coolant pump, water pump.
   c) Coolant hoses.
   d) Thermostats.
   e) Belts.
   f) Heat exchangers.
   g) Freeze plugs.
   h) Coolant requirements.
   i) Coolant overflow reservoir.

13. Discuss the electrical system and its components with regard to an available rescue apparatus from the AHJ.
   a) The battery.
   b) Generators and alternators.
   c) Voltage regulator.
   d) Electrical motors.
   e) Lighting systems.

Reference: IFSTA 2nd Edition, Fire Department Pumping Apparatus, pages 191-200.
Reference: Manufacturer's Specification manuals.

NOTE: For proper engine care, always allow the engine to warm up to normal operating temperature prior to shutting it down.

APPLICATION

Divide the class into small groups of 3 to 5 candidates, assign each group to a specific area of the available rescue service apparatus engine to inspect and/or service. For example: cooling system, electrical system, oil and lubrication system, air induction system, and the fuel system. Appoint a group leader to examine and record the conditions found in the assigned area before and after any servicing. Upon completion of the exercise have the group leaders individually address the class to report their findings utilizing a flipchart or chalkboard. Critique each group's findings as they complete their presentation. Allow one hour for this application.

14. Discuss the brake system components of an available rescue apparatus from the AHJ.
    a) Hydraulic systems.
    b) Air systems.
    c) Parking brake.

15. Discuss the steering system components of an available rescue apparatus from the AHJ.
    a) Manual steering systems.
    b) Power assisted steering systems.

16. Discuss the driveline components of an available rescue apparatus from the AHJ.
    a) Transmission.
    b) Drive shafts and support bearings.
    c) The differential.
    d) The universal joints.

17. Discuss the components of the exhaust system of an available rescue apparatus from the AHJ.
    a) Exhaust manifold.
    b) Muffler.
    c) Tail pipe.

d) Catalytic converters.

18. Discuss the tire and wheel conditions and their components of an available rescue apparatus from the AHJ.
    a) Tire pressure.
    b) Tire condition, depth of tread, type of tread, and wear points.
    c) Lug nuts; torque in place at the correct foot-pounds.
    d) Rim condition; single or split rim design.

Reference: IFSTA 7th Edition, Fire Department Pumping Apparatus, pages 191-202.
Reference: Manufacturer's Specification manuals.

APPLICATION

Divide the class into small groups of 3 to 5 candidates, and assign each group to a specific area of the available rescue service apparatus frame and chassis to inspect and/or service. For example: the brake system, steering system, exhaust system, driveline components, and the wheel and tires. Appoint a group leader to examine the frame or chassis and record the conditions found in the assigned area before and after any servicing. Upon completion of the exercise have the group leaders individually address the class to report their findings, utilizing a flipchart or chalkboard. Critique each group's findings as they complete their presentation. Allow one hour for this application.

19. Discuss general maintenance procedures for striking tools, prying tools, chopping tools, scissors or snipping tools, saws and knives.
    a) Striking tool handles should be solid and well set into the head.
    b) Handles can be protected from fracturing by securing rubber tubing or tape (duct tape or electrical tape) around the handle near the head.
    c) Striking surfaces should be routinely serviced.
    d) Axes or pointed tools should be kept sharp, but not be razor sharp.
    e) Blunt striking surfaces should be kept free of chips or cracks.
    f) Chopping tool heads should not be re-painted.

g) Chopping tool heads should be covered with a thin coat of light grade oil such as silicone lubricant or light machine oil.
h) Chopping tool head should have a slightly sharp edge.
i) Chopping tool handles should be checked for fractures, looseness and warping.
j) All handsaws should be free of rust, kept sharp or replaced when dulled and lightly oiled.
k) Knife blades should be sharpened or replaced after each use.

20. Cables and chains should be periodically inspected especially after being subjected to high stress and or heavy loads.
    a) Chains and cables should be rated for pulling a specific load. Check manufacturer's recommendations for rated capacity.
    b) Check for bad weld points, cracked chain, heavy oxidation, frayed or broken cable strands, severe nicks, elongation, and bent links. Destroy damaged or worn out cables and chains.

Reference: Fire Service Search and Rescue, 7th Edition, pages 72 through 75.

21. Point out that according to the National Safety Council, there is a maximum allowable wear for chains.
    a) Chain size- 1" MAW= 7/32".
    b) Chain size- 1 1/2" MAW= 5/16".

22. Point out the importance of inspecting all tools before and after each use.

Reference: Fire Service Search and Rescue, 7th Edition, pages 75 through 101.

23. To understand fire extinguishers, discuss the four elements that must be present for a fire to exist.
    a) There must be oxygen to sustain combustion, heat to raise the material to its ignition temperature, fuel to support the combustion and a chemical chain reaction between the other three elements.
    b) Remove any one of the four elements to extinguish the fire.

c) Not all fires are the same. Different fuels create different fires and require different types of fire extinguishing agents.
d) Class A fires are fires in ordinary combustibles such as wood, paper, cloth, trash, and plastics.
e) Class B fires are fires in flammable liquids such as gasoline, petroleum oil, and paint. Class B fires also include flammable gases such as propane and butane. Class B fires do not include fires involving cooking oils and grease.
f) Class C fires and fires involving energized electrical equipment such as motors, transformers, and appliances. Remove the power and the Class C fire becomes one of the other classes of fire.
g) Class D fires are fires in combustible metals such as potassium, sodium, aluminum, and magnesium.
h) Class K fires are fires in cooking oils and greases such as animal fats and vegetable fats.

24. Explain and describe the different types of fire extinguishers. Some types of fire extinguishing agents can be used on more than one class of fire. Others have warnings where it would be dangerous for the operator to use a particular fire extinguishing agents.
    a) Water and foam fire extinguishers extinguish the fire by taking away the heat element of the fire training. Foam agents also separate the oxygen element from the other elements. Water extinguishers are for Class A fires only; they should not be used on Class B or Class C fires. The discharge stream could spread the flammable liquid in a Class B fire or could create a shock hazard on a Class C fire. Foam extinguishers can be used on Class A and B fire only. They are not for use on Class C fires due to the shock hazard.
    b) Carbon Dioxide fire extinguishers extinguish the fire by taking away the oxygen element of the fire triangle and also removing the heat with a very cold discharge. Carbon dioxide can be used on Class B and C fires. They are usually ineffective on Class A fires.
    c) Dry chemical fire extinguishers extinguish the fire primarily by interrupting the chemical reaction of

the fire triangle. Today's most widely used type of fire extinguisher is the multipurpose dry chemical that is effective on Class A, Class B, and Class C fires. This agent also works by creating a barrier between the oxygen element and the fuel element on Class A fires. Ordinary dry chemical is for Class B and Class C fires only. It is important to use the correct extinguisher for the type of fuel. Using the incorrect agent can allow the fire to reignite after apparently being extinguished successfully.

d) Wet chemical is a new agent that extinguishes the fire by removing the heat of the fire triangle and prevents re-ignition by creating a barrier between the oxygen and fuel elements. Wet chemical or Class K extinguishers were developed for modern, high efficiency deep fat fryers in commercial cooking operations. Some may also be used on Class A fires in commercial kitchens.

e) Halogenated or Clean Agent extinguishers include the halon agents as well as the newer and less ozone depleting halocarbon agents. They extinguish the fire by interrupting the chemical reaction of the fire triangle. Clean agent extinguishers are primarily for Class B and Class C fires. Some larger clean agent extinguishers can be used on Class A, Class B, and Class C fires.

f) Dry powder extinguishers are similar to dry chemical except that they extinguish the fire by separating the fuel from the oxygen element or by removing the heat element of the fire triangle. However, dry powder extinguishers are for Class D or combustible metal fires only. They are ineffective on all other classes of fires.

25. Discuss the inspection, care, and maintenance of portable fire extinguishers.
    a) NFPA 10 is the standard used for inspection, care and maintenance.
    b) All portable extinguishers shall be hydrostatically tested in accordance with NFPA 10.
    c) Test results on high and low pressure cylinders are recorded differently.

d) Inspection includes checking the discharge nozzle for obstructions, cracks, dirt or grease deposits, checking cylinder shell for any deformity, confirm that operating instructions on name plate are legible, checking for presence of lock pins and tamper seals, and determine if cylinder is full by checking pressure gauge or weighing cylinder.
e) Check the inspection tag for date of previous inspection, maintenance, or charging.

26. Point out that if any extinguisher is deficient in weight by 10% or more, it should be removed from service and replaced.

Reference: IFSTA 6th Edition, Essentials of Firefighting, page 252.
Reference: Manufacturer's specification manuals.

APPLICATION

Supply the candidates with, or have the candidates bring in their various types of portable extinguishers. Divide the candidates into small groups. Supply each group with an extinguisher and have them conduct an inspection.

27. List all power tools on the apparatus and describe their respective inspection procedures to ensure they are operable.
    a) Hydraulic tools: pumps/engines, spreaders, cutters, shears, jacks, etc.
    b) Generators and associated electrical equipment and tools: lights, saws, etc.
    c) Compressors, stored air systems, and all pneumatic equipment: air chisels, air bags, air shores, air hammers, etc.
    d) Chainsaws, electrical and gas powered.
    e) Power winches.
    f) Fans, smoke ejectors, positive pressure ventilation fans, etc.

Reference: Fire Service Search and Rescue, 7th Edition, pages 79 through 84.
Reference: Manufacturer's Specification manuals.

28. Discuss preventive maintenance and inspection procedures for hydraulic spreaders.

a) Inspection and cleaning should follow each use.
b) Check for proper fluid levels.
c) Check for cracks and dents in the body and arms of the spreader.
d) Check alignment of the arms.
e) Follow the manufacturer's guidelines for any additional maintenance requirements.

Reference: Vehicle Rescue and Extrication, 2nd Edition, pages 231-232.

29. Discuss preventive maintenance and inspection procedures for hydraulic cutters.
    a) Inspection and cleaning should follow each use.
    b) Check for proper fluid levels.
    c) Check for cracks and dents in the body and blade.
    d) Check alignment of the arms.
    e) Check that all nuts, bolts, retainer rings, screws, and pins are in place and secured.
    f) Follow the manufacturer's guidelines for any additional maintenance requirements.

30. Discuss preventive maintenance and inspection procedures for hydraulic rams.
    a) Inspection and cleaning should follow each use.
    b) Check for proper fluid levels.
    c) Check for cracks and dents in the body and plunger.
    d) Check the controller for proper operation.
    e) Check that all nuts, bolts, retainer rings, screws, and pins are in place and secured.
    f) Follow the manufacturer's guidelines for any additional maintenance requirements.

Reference: Vehicle Rescue and Extrication, 2nd Edition, page 240.

31. Discuss general inspection procedures for air chisels.
    a) Lubricate all internal parts prior to putting tools into service.
    b) Inspection and cleaning should follow each use.
    c) Check for proper fluid levels.
    d) Tighten all loose parts.
    e) Keep inlets and exhaust free of debris.
    f) Keep all bits sharpened.

g) Follow the manufacturer's guidelines for any additional maintenance requirements.

Reference: Vehicle Rescue and Extrication, 2nd Edition, pages 248-249.

APPLICATION

Using equipment provided by the AHJ, have the candidates demonstrate performing an inspection on a hydraulic spreader, cutter, ram, and an air chisel.

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. 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.
Reference: CMC RRM 4th Edition, pages 18-19 & 23-36.

3. Discuss guidelines for selecting the proper rescue rope.
   a) NFPA 1983 has established guidelines for the rating based on tensile strength and design loads (safe working load, SWL).
   b) For technical use operations, the tensile strength of the rope shall be no less than 20 kN (4496 lbf) pounds.

Reference: High Angle Rescue Techniques, 3rd Edition, page 27.

4. 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 9,000 lbf general purpose rescue rope loaded with a 300 lb 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 5,100 lbf anchor bolt would yield an SLR of 17:1 or 5,100 lbf divided by 300 lbs 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 7650 lbf and the SLR would be 22:1 or 7,650 lbf divided by 300 lbs rescuer load.

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

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

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

Reference: High Angle Rescue Techniques, 3rd Edition, pages 27 through 28.
Reference: CMC RRM, Chapter 18, pages 169-184.

7. 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.

8. 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.

9. 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 a 7mm Prussik cord would be suitable. For a 1/2" mainline rope an 8mm 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, page 145.

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 technical use shall have a minimum major axis breaking strength, with gate closed, of 27 kN (6069 lbf.)
   f) Carabiners designated for general use shall have a minimum major axis breaking strength, with gate closed, of 40 kN (8992lbf.)
   g) NFPA 1983 certified carabiners will have a “P” for personal use (1995-2001), an “L” for light duty use (2001),”T” for technical use (2012) or a “G” for general duty use (1995-2012), 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 onto a hard surface may result in damage.
   b) Lubricate hinges and gate knurls with manufacturer recommended lubricants.

Reference: IFSTA 7th Edition Fire Service Search and Rescue, pages 120 through 122.
Reference: High Angle Rescue Techniques, 3rd Edition, pages 48 through 56.
Reference: CMC RRM 4th Edition revised, pages 37-45.

6. Discuss the design, use, and safety considerations of rigging rings.
   a) Steel rings are used for various load-bearing applications.
   b) They are also rated as a multi-directional anchor.
   c) Currently, there are no manufactured rigging rings that meet NFPA 1983, 2012.

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. Great consideration should be given to using an ascender as a rope grab in a mechanical advantage system; the forces applied can cause catastrophic failure at very low weights. Prussicks are a very forgiving rope grab that act as a clutch and provide warning for system overload without damaging the rope.
   b) **They are not for arresting dynamic falls**.
   c) There are free running cams that 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 of whether or not a load is applied.
   e) There are handled ascenders with teeth. They are designed for rope ascensions only.

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) A Figure 8 plate with appendages or ears on larger rings is commonly called Rescue 8. The ears prevent the rope from slipping out of place and forming a girth hitch.
   d) The Rescue 8 will easily accommodate up to a 5/8" single rope or 2 – 7/16" ropes.
   e) Most manufacturers recommend limiting rapelling to less than 100 ft due to twists in the rope and heat build up on the device.

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 device 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 Petzl I’D S.
    a) Petzl I’D S is for technical use.
    b) Has a multi-functional handle.
    c) Lowers heavy loads up to 250 kg (only for expert users; consult the Instructions for Use for the device)

15 Discuss the design, use and safety considerations of Petzl ID L
    a) Designed for general use loads
    b) Has a multi-functional handle.
    c) Lowers heavy loads up to 272 kg (only for expert users; consult the instructions for use for the device)

16 Discuss the design, use and safety considerations of the MPD.
    a) The MPD’s high-efficiency pulley, with an integral rope-grab mechanism, allows it to be used as a lowering device on the main line and belay line systems and be quickly changed over to a raising system without switching out or replacing hardware.

b) The combination of essential features into a single device simplifies on-scene rigging, expediting the rescue.
c) The MPD is UL Classified as a pulley, descent control device and belay device.

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 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 12.5 mm X 4 = 50mm (1/2" X 4 = 2". 5/8" rope would require 4" pulleys.)
    c) Side plates should be able to open so pulley can be placed anywhere on the rope.
    d) Several manufacturers have produced pulleys with swivels built into them.

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 system load ratio (SLR) for the system.

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

SUMMARY

This class is designed to introduce the Technical Rescuer candidate to basic rescue equipment as well as some of the specialized equipment that candidates may encounter in the field. It is a general class and the instructor should cover all the rescue disciplines. However, keep in mind that the more equipment to which the candidates can be exposed, the sooner they will be effective and versatile in the field.

This is the instructor's "show and tell" class. Gather as much equipment as available for demonstration purposes. If possible, arrange for dealers to attend the class and demonstrate specific characteristics of the equipment they represent. Application of the tools will come later.

Continuously emphasize to the candidates that equipment is used to increase speed and efficiency, but safety should never be neglected for the sake of speed.