TR: Vehicle Rescue Lesson One Vehicle Anatomy and New Technologies

DOMAIN: COGNITIVE / PSYCHOMOTOR

LEVEL OF LEARNING: COMPREHENSION / APPLICATION

MATERIALS

IFSTA Principles of Vehicle Extrication, 2nd Edition; NFPA 1006, Standard For Technical Rescuer Professional Qualifications, 2013 Edition; Vehicle Rescue and Extrication by Ronald E. Moore; NFPA1670 Operations and Training for Technical Rescue Incidents; audio visual equipment; access to various late model vehicles; laptop computer; multimedia projector; whiteboard or flipchart; and marking pens.

NFPA 1006, 2013 Edition JPRs

10.1.5 Isolate and manage potential harmful hazards
10.1.6 Determine access and egress points for vehicles
10.1.7 Create access and egress openings for rescue from a vehicle
10.2.3 Determine access and egress points for heavy vehicles and large machinery
10.2.4 Create access and egress openings for a rescue
10.2.6 Isolate and manage potentially harmful energy sources within heavy vehicles

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 and discuss a vehicle's anatomy and new vehicle designs and technologies as they relate to potential hazards that are faced during vehicle extrication.

ENABLING OBJECTIVES

1. The Technical Rescuer candidate shall correctly identify and discuss a vehicle's anatomy to include vehicle construction, design and material, crumple zones, bumper systems, air bags, side impact protection systems, and the related potential hazards that are faced during passenger vehicle extrication incidents.

2. The Technical Rescuer candidate shall correctly identify and discuss potential hazards during extrication incidents found in new technologies of alternative fuel vehicles.

3. The Technical Rescuer candidate shall correctly identify and discuss potential hazards during extrication incidents found in new technologies of electric vehicles.

4. The Technical Rescuer candidate shall correctly identify and discuss potential hazards during extrication incidents found in new technologies of hybrid vehicles.

5. The Technical Rescuer will identify other types of new alternative fuel vehicles that may be found in the future.

TR: Vehicle Rescue
Lesson One
Vehicle Anatomy and New Technologies

MOTIVATION

Even with the new safety technology incorporated into vehicles by the automotive industry, traffic accidents are still a leading cause of death. Vehicle rescue still tops the list of emergency responses made by emergency service personnel. This fact dictates the need for rescue personnel to continuously make sure that their skills in extricating victims from distorted masses of metal are proficient. Staying current on information regarding vehicle design, safety features, new technology regarding rescue equipment, patient care and stabilization techniques is essential if the rescuer is going to be as proficient as possible when performing extrication techniques involving vehicles and machinery.

PRESENTATION

ENABLING OBJECTIVE #1

The Technical Rescuer candidate shall correctly identify and discuss a vehicle's anatomy to include vehicle construction, design and material, crumple zones, bumper systems, air bags, side impact protection systems, and the related potential hazards that are faced during passenger vehicle extrication incidents.

1. Discuss construction designs of various types of passenger vehicles. Ask the students how these designs can affect their ability to safely and efficiently perform extrication.
    a) Steel accounts for much of the material composition in many vehicles today. However, there are many types of steel and steel alloy that are being used today and the Technical Rescuer

needs to be aware of these materials and their effect as it relates to the concepts of extrication.

b) There are three major design technologies utilized today in vehicle body design. They are the Unibody, Space Frame and Body over Frame.

c) In the Unibody design, individual pieces are welded together to make one complete vehicular unit. The exterior body panels complete the Unibody concept and add additional strength.

d) The Space Frame design is similar to that of the Unibody but does not depend on the exterior body panels for strength. On the Space Frame design the inner skeletal structure makes up the strength of the vehicle and many times is found to be stronger than that of the Unibody. The exterior panels are generally plastic and will be bolted or glued in place. The Saturn would be an example of the Space Frame design.

e) The Body over Frame design is found in full size cars, pickups and vans. It is simply a vehicle body placed over a full structural steel frame.

f) There are many new types of steel, alloy metals and plastics being used in the manufacturing process of today's modern vehicle.

Reference: Jones and Bartlett Vehicle Extrication, pages 40 – 42.

2. Discuss the many types of new metals that are being utilized in the design and manufacturing of vehicles today.

a) High Strength Steel – generally found in the hood, door skin and quarter-panels. Generally found in structural parts of the vehicle.

b) Mild Steel – found in the fenders, floor pans and rocker panels. This metal is easy to bend and form.

c) HSLA (High Strength Low Alloy steel) – is used to make pillars, side members, front rails and struts.

d) UHSS (Ultra High Strength Steel) – used to make door beams, dash reinforcements and bumper reinforcements.

e) Boron Steel – generally found in the A post and door intrusion beams. Boron is a very strong alloy material that is difficult to cut and drill and is very brittle.

f) Aluminum and Magnesium are also being used in many vehicle components. Aluminum is generally thicker but much lighter. Magnesium is lightweight and strong but is also very combustible. Magnesium can be found in roof reinforcements, seat brackets, steering columns and brake pedal brackets.
g) Another steel process is called Hydroforming. This process uses hydraulic pressure to force water and oil through steel to form seamless structures for additional strength. Metals made from this process will be found in the pillars, rails and engine cradles.

Reference: Jones and Bartlett Vehicle Extrication, pages 40 and 41.

3. Note that reciprocating saws as well as many older model hydraulic tools may find cutting and spreading Boron, a specific type of HSLA steel, provides greater resistance than other metals located on a vehicle.

4. Point out that another steel used in the construction of passenger vehicles is called micro alloy steel. It is used for collision beams and the support pipe going from A-pillar to A-pillar under the dashboard.
   a) Micro alloy presents the same problems as Boron, some early model hydraulic spreaders and cutters do not have the capability of effectively cutting or displacing these types of metal.

5. Discuss the fact that many vehicles are built on a space frame; lightweight metal frame covered by panels of plastic.
   a) Plastic can be found incorporated into bumpers, front hoods, spoilers, and trunk lids.
   b) Compact foam can be found inside the pillars and beams.
   c) Two types of foam filler are used. Acoustic foam is used to reduce vibration and outside vehicle noise. Structural foam which is very dense can be found in many structural members to add additional strength.

6. Discuss concerns regarding vehicles designed using plastic bodies.

a) Starting in the early 90's GM introduced the injection-molded plastic panels seen on their all purpose vans (APV).
b) Plastics are durable, flexible and lightweight. Several manufacturers have started using fiberglass matting and carbon fiber to reinforce composite materials for added strength.

7. Ask the students why plastic vehicles have caused the rescue community to re-think their tactical approach to extrication?
   a) Use of heavy-duty cutters and spreaders may prove ineffective due to the inability of finding a solid purchase point and plastic tends to disintegrate under force. Plastic will also absorb much of the force exerted by hydraulic rescue tools thus giving under the initial force then rebounding once the force is released.
   b) Reciprocating saw blades have a tendency to melt plastic causing the saw to bind, the use of a soap and water spray solution will increase the cutting proficiency by reducing the friction.
   c) Many plastic and composite parts can be simply removed much easier than trying to force them with extrication tools.

8. Discuss concerns regarding vehicles designed using aluminum.
   a) Many of the new luxury vehicles such as the Audi A8, Honda's Insight and Civic, and the Toyota Prius are using aluminum for frame and body panel construction. This is evident based on the aforementioned vehicles' body weight. The Honda Insight weighs 1,880 pounds. The Honda Civic weighs 2,732 pounds and the Toyota Prius weighs 2,765 pounds. Sheet steel is used in conjunction with the aluminum.
   b) Aluminum tends to tear, fold, or bend more easily than sheet metal or steel when being forced by the pressure of the hydraulic rescue tools.
   c) Locating solid purchase points from which to work may prove difficult. Cutting or disassembling may be a better option.

9. Discuss the theory behind crumple zones on passenger vehicles. Discuss how these zones can impact extrication.
    a) These zones are designed to crumple on impact, absorbing energy created by a crash thus reducing the impact force on the occupants.
    c) They are located at the front and rear of the vehicle.
    d) They are designed to progressively deform, creating a controlled deceleration.
    e) The crumpling effect can cause steel to become corrugated making it difficult to displace.
    e) Some engine mounts are designed to “buckle” forcing the engine towards the ground and not into the passenger compartment.
    f) Engines mounted in a transverse position create a “crush space” between the engine and the passenger compartment.
    g) Some vehicles have energy absorbing hoods and steering columns.
    h) Other safety features include dashboard support pipes, and a deployable roll bar system on some convertible models.

Reference: Vehicle Rescue and Extrication, pages 43 – 47.
Reference: Jones and Bartlett Vehicle Extrication, pages 41 and 42.

10. Identify the various types of door designs and discuss their impact on extrication procedures.
    a) Hinges are made of stamped C-shaped metal or a molded one piece cast hinge.
    b) Door hinges are either bolted or welded and pinned onto the doorframe.
    c) Some hinges use a reverse bolt technique, one bolt attached from outside the frame and the other attached from inside the frame.
    d) The hinges on third door vehicles are very difficult to cut with older model hydraulic cutters due to the thickness of the metal. Newer model hydraulic cutters are capable of cutting the new age metals. However, the rescuer should remember that the cutting forces will be generated through whatever is being cut, potentially creating a projectile by the cut metal.

Just remember for every action there is usually an equal reaction.

e) Cutting one leaf of the hinge is more effective than cutting the entire hinge at one time.
f) Hinges on a sliding door are made of stamped metal with a pivot feature.
g) Most minivans with sliding doors have three hinges; one at the roofline, one in the middle that glides along the sidewall of the van, and one at floor level.
h) Also, rescuers should be aware of pinned hinge assemblies in which a case hardened pin is used to create the swing of the door. When force is exerted on these pins they can separate under that force and become a projectile which could cause injury.

11. Point out that rear door lips may be several inches wide; thus, the ability to gain access to a solid purchase base can be difficult.

12. Emphasize that in addition to a Nader pin many models have a secondary striker plate and pin that can be found on front doors located near the roofline and on rear doors several inches above the Nader pin. It is not an actual locking mechanism.

Reference: Vehicle Rescue and Extrication, pages 47 – 53.
Reference: Jones and Bartlett Vehicle Extrication, pages 43 – 45.

13. Point out that steel collision beams were introduced in 1973 and are designed to give added occupant protection in the event of a side impact.
    a) Note that the common design for vehicles built in the 80s and early 90s was the boxed steel beam measuring 7" high and 2" thick.
    b) The current design of collision beams is a round tubular steel pipe.
    c) Beams can be constructed of any grade steel, from high strength low alloy, ultra high strength, and micro alloy to Boron.

14. Note that a frontal collision may drive the alloy steel beam into the A or B pillar causing a “dead bolt” effect,

increasing the difficulty of gaining access if the cutters used by the AHJ will not cut the metal.

15. Point out that collision beams can buckle and the sheet metal attachment points can tear causing the beam to penetrate into the passenger compartment.
    a) The same scenario may occur when rescuers are attempting to “pop” a severely damaged door with a hydraulic spreader.

16. Discuss safety concerns regarding drive shafts.
    a) With the advent of front wheel drive vehicles, drive shafts are becoming less numerous in passenger vehicles.
    b) SUVs, pick-up trucks, buses, and large trucks will continue to use drive shafts.
    c) The biggest danger regarding drive shafts is heating during a vehicle fire.
    d) Moisture can build up in the shaft and when exposed to heat the resulting internal pressure can cause the shaft to explode, but rarely results in flying debris.
    e) In the event of a fire, cooling the undercarriage with water will reduce the risk of an explosion.

17. Discuss safety concerns regarding electric fans.
    a) Many vehicles have independent electrically operated cooling fans that can still activate after a frontal crash.
    b) Personnel gaining access to the engine compartment need to be aware the fan can activate at any time if the electrical system is still intact even if the engine has been shut off.
    c) Cutting or pulling the power wire at the motor can neutralize the electric fan.
    d) It should be noted that many Hybrid vehicles are utilizing a high voltage cooling fan. The high voltage cooling fan should not be disconnected since it is part of the high voltage system.

Reference: Vehicle Rescue and Extrication pages 53 - 54.

19. Discuss safety concerns regarding various types of standard fuel systems.
    a) Most passenger vehicle fuel tanks are constructed of lightweight metal.

b) Fuel capacity can vary from 10 – 40 gallons.
c) Hybrid vehicles utilize a lightweight fuel tank that is plastic and contains approximately 10 to 13 gallons of fuel.

20. Point out that many of the new tanks are constructed of blow molded, high density, and polyethylene plastic.
    a) Under normal crash conditions, these tanks perform very well; in fire conditions they could melt and rupture and spill their contents.

21. Stress that testing done by the U.S. Department of Transportation found that plastic tanks exposed to fire ruptured between 2½ - 4½ minutes after initial exposure to fire.

22. Emphasize that fire control is essential when the threat of fire is even remotely possible.

23. Note that fuel tank location on older model vehicles is between the rear bumper and rear axle. On newer models the tanks are located between the two axles, giving the tank greater protection in the event of a rear end collision.

24. Point out that fuel lines, hydraulic lines, and electric lines run from the rear of the vehicle to the front, near both rocker channels, under the hollow rocker channel or in the passenger compartment in some models.
    a) Cutting into these lines may result in leaking fuel and or electric sparks.
    b) Spreaders and cutters should not crimp or cut through the rocker panels. This will most often depend on the type of vehicle and what hazards may be located in the rocker panels.

25. Discuss the urban legend that fuel lines can be found running from the rear, up through the roof pillars. These lines are generally not fuel lines but rather drain lines or coolant lines depending on the type of vehicle. The coolant lines are generally found on vehicles with rear seat air conditioning units and can be a hazard if cut due to the heated coolant that could be released.

26. Point out that in some vehicles fuel pumps are located along the undercarriage near the engine with fuel lines going to the engine and fuel tank.
    a) New model vehicles have the fuel pump located in the fuel tank; fuel is pumped electronically when ignition is on at a pressure of approximately 90psi.
    b) These pumps can still operate after a crash if the ignition is still on creating a potential fire threat.
    c) Many fuel systems are sealed systems consisting of emission control components, sealed fuel tank, a vapor-holding canister, and vapor recovery lines. The fuel in the Toyota Prius is actually in a rubber bladder protected by a metal fuel tank.
    d) When exposed to intense heat, a sealed system can build up enough internal pressure to trigger an explosion of any of the fuel system.

Reference: Vehicle Rescue and Extrication, pages 54 - 57.

27. Identify new technologies regarding auto glass and the impact it has for rescuers during extrication.
    a) The newest type of glass being found on the market is called enhanced protective glass (EPG).
    b) The composition is very similar to laminated glass used in front windshields.
    c) EPG is designed for use in side and rear windows as a deterrent to vehicle break-ins.
    d) After reviewing occupant ejections during crashes, the National Highway Transportation and Safety Administration determined that 45% could have been prevented if the vehicles were equipped with an alternative glass such as a laminated side window glass.
    e) Laminated glass has been available in the Audi A8 as an option since 1995 and as standard equipment since 1998.
    f) BMW now offers a security-glass option on selected vehicles.
    g) Mercedes-Benz S class sedan offers a laminated side and rear glass as standard equipment since 2000.
    h) Volvo S80 and V70 sedans also offer laminated side windows as an option.

i) If damaged in a crash, laminated side or rear windows respond similarly to a front windshield, a spider-web pattern of cracks.

28. Point out that identification of EPG is located in the lower corner of side and rear windows using the terms Laminated or Toughened.

29. Discuss the technique for removing an EPG window and how it is the same as a windshield.

Reference: Vehicle Rescue and Extrication, pages 57 – 59.
Reference: Jones and Bartlett Vehicle Extrication, pages 49 and 50.

30. Identify the function of the battery as it relates to the vehicle electrical system.
    a) The battery is used to store power to start the engine and to run auxiliary devices such as clocks, radios, and alarms when the engine is turned off.

31. Identify the various locations batteries may be found on a vehicle.
    b) Most often located in the engine compartment.
    c) Items such as corner braces, air filter housing or other components may be placed above the battery making electrical system shutdown potentially difficult.
    d) Batteries located in the engine compartment mean that the battery is within the crumple zone during the crash and therefore has the potential of being hidden by crumpled metal.
    e) If the battery is not in the engine compartment rescuers should look for a two-screw post marked with yellow lettering.
    f) One terminal is marked “positive” (+) and the other is marked “negative” (-).
    g) These terminals are jumper cable connection points used to jumpstart a vehicle in the event of a dead battery.
    h) The presence of these terminals indicates the battery is in a remote mounted location such as the fender wells, under the rear seat or trunk.

i) Cables attached to the battery run through the inner fender to the remote jumper terminal screw post.

32. Point out that when the remote terminals are disconnected the vehicle's electrical system is shutdown, but the wiring going back to the battery is still energized.

33. Note that depending on the make and model of the vehicle, the batteries can be located in various locations within the vehicle.
    a) In many late model GM sedans, the battery is mounted under the rear passenger seat.
    b) Electrical system shut down in these vehicles is accomplished at the remote terminal under the hood; but to completely neutralize the battery and wiring, the rear passenger seat must be removed.
    c) BMW, Volvo, and Mercedes Benz routinely place the battery within the trunk.
    d) The battery in the Toyota Prius is located in the trunk on either the left or right rear corner depending upon the model year. This is a hybrid electric car.

34. Point out that in many late model passenger vehicles, like diesel trucks and buses, multiple batteries are possible.
    a) A valuable "second battery" clue for first responders is the presence of multiple positive cables attached to the posts.
    b) Another clue is marking on the vehicle indicating it has a diesel engine.

35. Discuss that BMW has developed what is called a "safety" terminal. The battery is located in the passenger's side wheel well in the trunk.
    a) The battery has a small explosive charge integrated into the positive cable that activates when the frontal airbags are deployed separating the hot wire and shutting off power to the starter.
    b) A smaller hot wire is attached to the positive terminal providing power to locks, dome lights, four-way flashers and the GPS navigation signal. This wire will have to be disconnected to totally neutralize the vehicle's electrical system.

36. Point out that due to the increased electrical loads being placed on a vehicle's electrical system by added accessories, manufacturers are considering the installation of a 48 volt electrical system in future vehicles.

37. Discuss the reasons for shutting down a vehicle's electrical system.
    a) Electrical system shutdown allows the airbag capacitor to begin draining its stored energy.
    b) It reduces the chance of electrical arcs or sparks as rescuers attempt to gain access using various tools.
    c) Vehicles using 42 volt systems make electrical shutdown especially important.
    d) Without power the starter and other electrical accessories will not accidentally operate, making the scene safer for the rescuers and the victim.

38. Discuss interior rescuer's role in initiating an electrical system shutdown.
    a) Once interior access is gained, locate window, trunk release, hatchback, or tailgate latch.
    b) Verify that the gear selector is in a locked position and the ignition switch is off.
    c) Remove the ignition key and place it on the dash, or give it to the Safety Officer. Note: Due to some keys being perimeter keys, they may work up to several yards away.

39. Discuss exterior rescuer's role in initiating an electrical system shutdown.
    a) Determine the location of battery or batteries.
    b) Assess the condition of the front bumper and the front of the vehicle.
    c) If work must be performed in front of the vehicle, verify that the bumper is not damaged, or secure the damaged bumper.
    d) If the bumper is damaged, the best choice may be to work from the side of the vehicle.
    e) Disengage the hood latch.
    f) Pry the hood open at the hinge points.
    g) Locate the battery or batteries and the remote terminals.
    h) Neutralize any hazards that may exist regarding the battery, leaking fluid, or flammable vapors.

40. Identify the steps for shutting down power at the battery.
    a) Cut or disconnect the negative cables first, then the positive to achieve total electrical system shutdown. Do not let the cables make contact with any metal parts.
    b) Consider cutting both cables a second time at a minimum of a 2” spacing to avoid secondary contact.
    c) If cables are disconnected at the terminal, fold the cables back on themselves and cover the cable clamps with insulating tape.
    d) If, after disabling both cables, there is evidence that power is still present, seek out the second battery and repeat shut down tactics.
    e) One way to neutralize vapors leaking from the battery is to apply shaving cream to the area where cutting or disconnecting of the battery will take place.

Reference: Jones and Bartlett Vehicle Extrication, pages 190 and 191, and pages 94 and 95.

41. Discuss how air bags protect vehicle occupants.
    a) They were introduced into the U.S. in 1972 installed in 831 Mercury Monterey’s by Ford Motor Co. in conjunction with the Eaton Corporation.
    b) The initial location of the air bag was under the steering wheel hub and right front dashboard, and designed to protect the driver and front seat passenger involved in a frontal crash.
    c) Air bags can only be effective when used in conjunction with seat belts, thus the reference by the automotive industry “supplemental restraint system” (SRS).

42. Stress those occupants not using seatbelts or occupants out of position in vehicles with an SRS could receive significant injuries or be killed by an inflating air bag.
    a) Many automakers are installing seatbelt pre-tensioner systems that help keep the seatbelt tight on the occupant at the moment the frontal airbags deploy.

43. Point out that newer vehicles have side impact airbags installed along rooflines, inside doors, and seatbacks.

Reference: Vehicle Rescue and Extrication, pages 2 - 5.

44. Discuss how an air bag system works.
    a) They consist of crash sensors (accelerometers), an electronic control unit and air bag modules located throughout the interior of the vehicle.
    b) The impact triggers one or more of the air bag crash sensors, the sensor sends a signal to the air bag control module and then sends a signal to the seatbelt pre-tensioners and whichever air bag module is needed to deploy.
    c) Placement of multiple sensors ensure that at least one sensor will respond rapidly no matter what part of the vehicle is hit, and dictates that specific air bags deploy while others remain inert.
    d) Sensors for side impact bags can be located on the side of B and C pillars, inside the door panel or within the airbag control unit.
    e) The control unit, about the size of a cigar box is usually located under the hump beneath the dash and instrument panel.

Reference: Jones and Bartlett Vehicle Extrication, pages 88-92.

45. Point out that in those vehicles with driver side frontal bags, the air bag actuator unit is located in the wheel hub with the air bag.
    a) Most air bags will deploy on impacts equal to 10 - 12 mph.
    b) The inflator module is either a chemical inflator or a pressurized gas canister.
    c) ABS and window curtain airbags inflate by actuation of a compressed gas cylinder.
    d) Cutting into these cylinders is like cutting into a fragmentation grenade.
    e) Location of these cylinders include the base of the “C” pillar, the “A” pillar (near the dash) and at the roof line just below the “A”, “B”, “C” or “D” pillars.
    f) All interior plastic covering around pillars and roofline should be stripped prior to any cutting.
    g) A new extrication motto to remember is “Strip before you Rip.”

h) Air bag modules can be found in the wheel hub, in the dashboard, under the dashboard along the roofline, in the door panels, and in the seat side bolsters.
i) Upon impact the igniters are activated producing a chemical reaction (ignites sodium azide) producing nitrogen gas, pressurized argon, or helium.
j) Full deployment takes about 50 milliseconds.
k) Gas is vented through vent holes on the airbag once it reaches full capacity.
l) The first generation side impact bags were introduced in 1995 as torso bags, protecting the rib cage.
m) Side impact bags are smaller than the frontal bags and inflate within 20 milliseconds of impact.
n) Side impact bags give added protection to occupants in T-bone type crashes and compensate for lack of a crumple zone and crush space.
o) Newer side air bags incorporate a head protection bag in conjunction with the torso bag.

46. Point out that the National Transportation Safety Board recommends that nothing be placed between the rescuer and the airbag module during a rescue operation.

47. Identify and discuss the vehicles equipped with new airbag technology. Ask the students for examples.
a) Kia Motors introduced the first knee bag in their 1996 Sportage SUV.
b) The first airbags installed in an SUV sold in the U.S. were in the 1993 Jeep Cherokee.
c) The National Highway Traffic and Safety Administration (NHTSA) allowed factory installed cutoff switches for passenger side airbags in 1996 for passenger vehicles without a rear seat.
d) In 1998 Ford and Chrysler introduced the “depowered bag,” designed to inflate with less force and provide a softer supplemental restraint.
e) In 1998 BMW introduced the Head Protection System (HPS).
f) In 2002 the Dodge Ram 1500 rolled off the assembly line with roof mounted side impact bags.

g) As of 2000, many vehicles are fitted with dual-action bags equipped with two igniters that deploy in a two-stage manor, initially inflating to 50% capacity. Then, the second igniter will activate if the control module determines the need for full deployment.

Reference: Vehicle Rescue and Extrication, pages 5 - 20.

48. Discuss the concepts of a “SMART BAG.”
    a) They were introduced in 1995 and found initially in the Mercedes and BMW.
    b) The system is designed to sense an impact and deploy the appropriate airbags.
    c) The “SMART BAG” recognizes that a seat is occupied based on 40 pounds of pressure being exerted on the seat.

49. Point out that if an occupant is using a restraint system the control module will determine if, as calculated by the point of and speed of impact, a bag needs to be deployed in addition to the restraint device.
    a) Pressure switches in the seats will let the control module know how many occupants are in the vehicle.
    b) A “SMART BAG” will not deploy into an unoccupied space.

50. Stress that rescuers crawling on the seats will not activate the air bag because the system will only activate upon impact.

NOTE: Rescuer may activate height/weight safeties which prevents airbag from deploying while performing patient care. Not that airbag will deploy, but the safety has been removed. Rescuers should always use extreme caution while working around airbags as they may deploy at any given time without warning. Any undeployed airbag should always be treated as a loaded gun.

Reference: Vehicle Rescue and Extrication, pages 11 - 12.
Reference: Jones and Bartlett Vehicle Extrication, page 92.

51. Discuss “scanning” procedures for identifying the number and location of vehicle air bags.

a) Scanning should begin after rescuers have determined that the vehicle is safe to touch, work inside and around.
b) Air bag location may include the wheel hub in the front dashboard of the passenger side, under the dashboard, under dashboard under steering column, the armrest area of the front and rear doors, the outer edge of the front seat, the middle and top of the A pillar, the B pillar at the roofline, the B pillar at the front and rear door latch, the C pillar at the roof line, the corner of the windshield and the latching edge of door.

52. Emphasize using extreme caution working around un-deployed air bags, even after batteries have been disconnected and capacitors have drained. The potential for an airbag to deploy still exists.

53. Stress that rescuers should be familiar with the automakers ID tags for identifying the presence of various types of air bags.

Reference: Vehicle Rescue and Extrication, pages 27 - 35.

54. Discuss design features and safety concerns regarding seatbelt systems.
    a) The new seatbelt design is known as the “all-belts-to-seats” system.
    b) The seatbelt, take-up spool, and seatbelt pre-tensioner are all located within the outboard edge of the seat.
    c) The shoulder portion is designed to securely wrap around the occupant’s body, increasing the efficiency of the overall restraint system.
    d) Rescuers should use caution when moving or removing this type of seat.
    e) Some seat belt assemblies are mounted in the door.
    f) Rescuers must cut door-mounted seatbelts before forcing a jammed door to open.

55. Discuss features and safety concerns regarding seatbelt pre-tensioners.
    a) They are designed to reduce any slack that may be present at the time of impact.

b) At the time of impact, the pre-tensioner can tighten a seatbelt up to six inches in a frontal impact using one gram of propellant.

56. Discuss the two types of pre-tensioning systems that are in existence.
    a) The Buckle Type, the pre-tensioner attaches to the seatbelt buckle end. A small explosive charge is used to generate a pressurized gas that pulls a cable that forces the seatbelt down thus tightening the shoulder and waist strap around the occupant.
    b) The Spool Type, known as the “take-up spool design.” A small chemical charge is used to generate a gas that backwinds the take-up spool and pulls the seatbelt tight.

57. Discuss the various locations of pre-tensioner systems in vehicles.
    a) The entire pre-tensioner system is usually found in the B pillar.
        (1) American cars typically have retractor type pretensioners. Foreign cars typically have buckle type pre-tensioners.
    b) Pre-tensioners can also be installed on rear seats.
    c) Rear seat pre-tensioners are usually located near the take-up spool bolted under the metal of the rear speaker deck or inside the hollow space of the rear quarter panel, in front of the rear wheels.
    d) Pre-tensioners can be located by peeling the interior trim off the B pillar.

58. Point out that pre-tensioners are designed not to deploy unless the air bags deploy.

59. Discuss the signs of an activated pre-tensioner system.
    a) Signs that indicate that the buckle type pre-tensioner has been activated include; the buckle is positioned at or below the top of the seat cushion and/or the B-pillar interior trim has been displaced by the pyrotechnic charge that activated the pre-tensioner.

60. Note that if the system is electrically operated, disconnecting the batteries can neutralize the pre-tensioning systems.
    a) Before doing a roof flap or roof removal, expose the pre-tensioners located in the B pillars.

61. Emphasize: do not cut the pre-tensioner. It is activated by a pyrotechnic firing device.

62. Point out that the Mercedes-Benz pre-tensioning system activates in both frontal and rear-end impacts.

63. Discuss the “slow release” type of seatbelt system.
    a) Special threads are sewn into the area seatbelt near the permanent attachment point.
    b) On impact these threads will stretch and eventually tear acting as a shock absorber to slow down the forward movement of the occupant.
    c) For identification, rescuers working in the seat area should look for a patch of fuzzy threads low on the seatbelt.

Reference: Vehicle Rescue and Extrication, pages 70 - 72.
Reference: Jones and Bartlett Vehicle Extrication, page 92.

PRESENTATION

ENABLING OBJECTIVE #2

The Technical Rescuer candidate shall correctly identify and discuss potential hazards during extrication incidents found in new technologies of alternative fuel vehicles.

1. Discuss the safety issues for alternative fuel systems. How do they affect extrication?
    a) Alternative fuel sources include natural gas, propane, hydrogen and electricity.
    b) Hydrogen vehicles have compressed hydrogen cylinders ranging from 4500-6000 psi.
    a) The two types of natural gas are compressed natural gas (CNG) and liquefied natural gas (LNG).
    b) There are an estimated ½ million natural gas operated vehicles on the road today.
    c) Propane or butane powered vehicles use liquefied petroleum gas (LPG).

d) The National LP Gas Association estimates there are about 1.5 million vehicles using LPG as a fuel source.

Reference: Jones and Bartlett Vehicle Extrication, page 58.

2. Point out that a vehicle's alternative fuel system can be a "dedicated system" operating solely on natural gas or propane-butane, or a duel fuel system which allows the operator to switch from gasoline to the alternative fuel source with a manual selector switch located in the driver compartment.
   a) Natural gas has a flammable range of 4% - 14% air to fuel ratio and an ignition temperature of 1300 degrees F. compared to 800 degrees F. for gasoline.
   b) Natural gas is lighter than air. It is 65% of an equivalent air volume, and is odorized with mercaptan that gives it its distinct smell.
   c) Propane-butane (LPG) has a flammable range of 2.4% - 9.5% air to fuel ratio and an ignition temperature of 871 degrees F.
   d) LPG is 1½ times heavier than equivalent air volume, and once released from its container, will expand 270 times its liquid volume.

3. Point out that in the event of a collision both CNG and LPG tanks are rated to have twenty times the resistance of a standard fuel tank. They are also equipped with a pressure relief valve. These tanks are constructed of a composite fiber glass wound cylinder resembling a composite air bottle. They can be located in different locations on the vehicle depending on make and model. There can also be more than one cylinder on the vehicle.
   a) A shut-off valve will be located near the storage tank or under the hood near the engine.
   b) Some states require vehicles using alternative fuels to display a decal denoting the fuel and are located on the driver's side of the rear bumper.
   c) If leaks are verified by rescue personnel, fire control measures should be established immediately and only trained personnel in appropriate PPE should attempt shut-off procedures.

d) Could still have potential for BLEVE or sudden rupture during vehicle fire.

Reference: Jones and Bartlett Vehicle Extrication, pages 59-65.

4. Note that fuel cell vehicles use hydrogen to generate electricity. The electricity is then used to power the vehicle.
   a) Fuel cell vehicles require hydrogen as part of the electric generating action.
   b) In passenger vehicles hydrogen is stored in a Type 3 or 4 pressure vessel. These tanks are constructed of either Carbon Fiber wrapped aluminum or polymer.
   c) Hydrogen vehicles utilize a high voltage electrical system that can be charged with 200 to 400 volts. As with many Hybrid vehicles the high voltage wiring can be identified by orange colored wiring.
   d) To deactivate the high voltage system the rescuer should turn off the vehicle.
   e) Once the vehicle is turned off, the delivery system will be deactivated within a few minutes and the only remaining high voltage component containing energy will be the actual storage system.
   f) For situations involving a possible hydrogen fire, rescuers should wear full structural PPE including SCBA. Also, the use of high voltage rubber protective gloves may be necessary along with Static Dissipative equipment.
   g) UV detectors and/or hydrogen detection devices may be necessary to identify the invisible hydrogen flame and release of gases.
   h) Fuel cell cars that have a gasoline tank use the hydrogen from breaking down the hydrocarbons in gasoline. Hydrogen is NOT stored in typical gasoline tanks.
   i) Fuel cell vehicles, minivans, and trucks typically use compressed hydrogen tanks (gaseous or possibly liquid).

Reference: Vehicle Rescue and Extrication, pages 81 - 87.
Reference: Jones and Bartlett Vehicle Extrication, pages 65-72.

PRESENTATION

ENABLING OBJECTIVE #3

The Technical Rescuer candidate shall correctly identify and discuss potential hazards during extrication incidents found in new technologies of electric vehicles.

1. Discuss the concepts of the all-electric vehicle and how these vehicles affect extrication.
   a) The EV1 was the first all electric vehicle mass produced. It was introduced by GM in 1996 and distributed through Saturn.
   b) They are equipped with standard safety features including dual frontal air bags.

2. The EV1 was powered by twenty-six 12 volt lead acid batteries.
   a) These vehicles could travel up to 90 miles without a charge.
   b) The battery bank ran from front to rear along the center floor pan, between the two front seats.

3. Point out that the lead acid battery is now being replaced with the more efficient nickel-metal-hydride battery (NI-MH).

4. Corporate fleets make up the majority of buyers for all electric vehicles today.

Reference: Jones and Bartlett Vehicle Extrication, pages 77-79

PRESENTATION

ENABLING OBJECTIVE #4

The Technical Rescuer candidate shall correctly identify and discuss potential hazards during extrication incidents found in new technologies of hybrid vehicles.

1. Discuss the concepts of the Hybrid gasoline/electric vehicles. Ask how these vehicles can affect extrication.
   a) To counter the short-range travel limitations of the all-electric vehicle, manufacturers are now producing hybrid gasoline/electric vehicles.

b) A hybrid vehicle is one that combines an internal combustion engine with the electric motor of an electric powered vehicle.
c) Currently manufacturers are developing HEVs that use hydrogen fuel cells and turbo-generators.

2. Identify and discuss examples of the various HEV's in the United States.
   a) Point out that Honda sells the Insight HEV and Toyota sells the Prius in the U.S.
   b) As of January 2009 there are over 20 different hybrid vehicles for sale in the U.S.

3. Discuss the series hybrid system.
   a) The vehicle can use the electric motor alone for slow speed stop and go traffic (up to 20 - 30 mph) or can operate primarily from the gasoline engine.
   b) The vehicle can be powered by the electric motor, internal combustion engine or both.

4. Discuss the parallel hybrid system.
   a) It uses the electric motor to restart the gasoline from a stop and to supplement the gasoline engine to supply power to the wheels.
   b) Cannot operate solely using the electric motor.

5. Discuss the presents of mild hybrid systems.
   a) The electric motor on the vehicle simply restarts the gasoline engine from a stop. The electric does not power the vehicle down the road at any time.

6. Discuss the construction features of the hybrid vehicle. Ask how these different features can affect extrication procedures.
   a) The Honda Insight structural components are constructed entirely of aluminum.
   b) All non-structural application material is made of plastic including front fenders, spoiler, underbody cover and rear fender skirts.
   c) The aluminum body will tend to bend and tear unlike typical body components constructed of steel.
   d) Most hybrid vehicles feature the same body and chassis construction of any other car.

e) Discuss the 12 volt electrical system used for hybrid vehicles.
f) All hybrid vehicles use two electrical systems, a standard 12 volt system and a high voltage system.
g) There is a separate battery for each system.
h) The 12 volt system is a lead-acid battery much like a conventional battery.
i) The 12 volt battery operates the vehicle's accessories.
j) 12 volt battery locations vary; some may be found underneath the hood or located in the trunk of the vehicle.

7. Discuss the hybrid high voltage system and its impact on extrication.
   a) The high voltage system is designed to operate the electric motor in the hybrid vehicle.
   b) The high voltage system can range from 42 volts to 300 volts.
   c) The pack weighs approximately 110 pounds.
   d) The Honda high voltage battery generates 144 volts and weighs approximately 48 pounds.
   e) It consists of 120 dry-cell batteries connected in a series.
   f) The battery pack is found inside the hatchback beneath the carpeting and a metal floor-pan immediately behind the driver and passenger seat.

8. Identify and discuss occupant safety features of hybrid vehicles, and why it is important for rescuers to identify these features during extrication procedures.
   a) Most hybrid vehicles have the same safety features as the typical passenger vehicle; including airbags, supplemental restraint systems, and seatbelt pre-tensioners.

9. Discuss the four action plans and safety concerns for first responders approaching hybrid cars involved in a crash.
   a) Control the ignition key.
   b) Disconnect the 12 volt battery.
   c) Pull all of the fuses underneath the hood.
   d) Operate the high voltage service disconnect switch.

e) Toyota recommends that responders utilize lineman's gloves when disconnecting the high voltage disconnect switch.
f) If the vehicle has a keyless ignition system, the responder may have to search to find the remote and move it at least 6 feet away from the vehicle.

10. Discuss safety concerns for first responders approaching hybrid cars involved in a crash.
    a) Responders approaching an accident scene involving the hybrid vehicle should perform a primary and secondary size up. Remember that the Hybrid may not be identified readily; example: Lexus simply uses a lower case h behind the vehicle model to identify a Hybrid (Lexus 400h is the Lexus Hybrid SUV).
    b) Once the Hybrid is identified, secure the vehicle by placing chocks in the front and rear of the tires to prevent movement in the event the Hybrid is a Smart vehicle.
    c) Responders should then gain access and perform an interior survey to identify airbag deployment and if all SRS systems have deployed. The interior rescuer can also identify if the vehicle is a Smart vehicle by looking for the green "Ready" or Auto Run light being illuminated on the dash.
    d) The interior rescuer will also play an integral role in securing the vehicle and isolating the high voltage electrical system.
    e) While the interior rescuer is performing interior safety measures the exterior rescuer should locate the 12 volt battery and disconnect same. After the 12 volt system is disconnected allow 5 minutes for power drain on capacitors at which time the high voltage system should be isolated.
    f) The interior rescuer should turn the vehicle off, place the vehicle in park and remove the smart key (at least 15' from the vehicle) and verify that the green "Ready" or "Auto Run" light goes off, if applicable.
    g) The rescuer should never attempt to disengage the high voltage battery system or tamper with any of the high voltage components. These components may be orange, yellow, or blue.

11. Point out that on a hybrid vehicle, the gasoline engine shuts off when the vehicle stops.
    a) All accessories are run by the 12 volt electric system.
    b) From a stopped position, when the accelerator pedal is depressed the electric motor engages or the gasoline engine can restart and suddenly drive away.
    c) The gasoline engine activates when it senses the need for more acceleration or in incline.

12. Point out that on a hybrid vehicle a feature known as auto stop mode may shut off the engine when the vehicle is stopped.
    a) The engine instantly starts when the clutch is depressed and the driver shifts into first gear.
    b) The vehicle can drive away under electric or gas power simply by depressing the gas pedal.

13. Emphasize that emergency responders need to realize, with a hybrid electric vehicle (HEV) when the engine is off there is no sound from the engine compartment or the electric motor.
    a) With an HEV a silent car does not necessarily mean a safe car.
    b) The HEV is in a sleep mode and may wake up any time.

14. Discuss ways for rescuers to note that the HEV is still in the ON mode, and potentially dangerous.
    a) When a hybrid vehicle is stopped in traffic or as the result of a crash the vehicle goes into the "Auto Idle Stop Mode."
    b) Emergency responders should look for indicators that the vehicle is in auto stop mode by looking for an auto stop or ready light.

15. Stress that chocking the wheels is critical with an HEV.

16. Discuss tactical concerns regarding Ni-MH battery pack damage, fire and haz-mat.
    a) All battery pack cell are sealed within a metal container, emergency responders should not attempt to disassemble the container, even if evidence of a fire exist.

b) Cool the container using water; once the container is sufficiently cooled a Ni-MH battery will burn itself out.

17. Stress the importance of using appropriate PPE and breathing apparatus when conducting firefighting tactics.
    a) Toxic fumes from a leaking battery or burning plastic may be present.

18. Point out that generally the battery packs remain intact after a crash and pose little threat to emergency responders.
    a) If the parallel high voltage cables located under the vehicle receive significant damage the high voltage battery is designed to short circuit, thus neutralizing the entire electrical system. In addition, there are ground fault circuit interrupters installed to disconnect the high voltage battery pack in the event of a malfunction.
    b) A crushed or opened high voltage battery can be tagged by the officer in charge so that later a request for proper disposal can be made. May have to contact the dealer or manufacturer for proper procedures.

Reference: Vehicle Rescue and Extrication, pages 87 - 98.
Reference: Jones and Bartlett Vehicle Extrication, pages 72 – 76.

PRESENTATION

ENABLING OBJECTIVE #5

The Technical Rescuer will identify other types of new alternative fuel vehicles that may be found in the future.

1. Bio Diesel – with fuel prices on the rise, Bio-Diesel is a new available alternative. There are millions of vehicles already on the road ready to utilize this fuel product. Made of new or waste vegetable oil its consistency is 20% Bio-Diesel and 80% Petroleum Diesel.

2. Response and safety considerations are the same as that of a petroleum diesel fueled vehicle.

3. Another fuel alternative that is becoming prevalent is E85. This fuel is 85% Ethanol and 15% gasoline.

4. Safety precautions with vehicles fueled by this product are different from other fuels in that normal firefighting procedures for other fuels are ineffective on E85. The reason for this is that E85 will mix with water making water an ineffective firefighting agent. E85 also will destroy foam blankets created by normal AFFF firefighting foams. Alcohol resistant foams prove effective in the extinguishment of fires fueled by E85. AR-AFFF should be applied at a 3% ratio for E85 fires.

Reference: Jones and Bartlett Vehicle Extrication, page 65.

APPLICATION

Divide the class into equal groups. Using several of the candidate's vehicles as props, or by visiting a dealership, have each group perform a vehicle size-up to include an air bag scan. Document the number and location of air bags, the number and the location of the batteries, and the type of fuel system, such as gas, diesel, LPG, CNG, or hybrid.

SUMMARY

This lesson plan exposes the Technical Rescuer candidate to the new technology and safety issues concerning many of the late model vehicles that are on our highways. The automotive industry is much like the computer industry in that new designs, new safety features with inherent hazards and challenges for rescuers are being introduced frequently. Rescuers need to stay in tune with training techniques and technical information in order to perform at a high proficiency level and maintain a safe working environment at a vehicle rescue incident.