

TRAINING BULLETIN #5
6/87
AUTOMOBILE FIRES AND ASSOCIATED HAZARDS

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An Engine Company responds to a vehicle fire in the number 2 lane on the San Diego Freeway. The California Highway Patrol (CHP) has stopped four lanes of traffic (downhill from the vehicle). The Engine Company spots uphill/upwind from the burning vehicle, a late model Volkswagon van. A 1 1/2" hose line with a dry chemical extinguisher as backup are positioned to advance on the fire. Suddenly, without warning, the burning VW van begins rolling downhill in the direction of the stopped traffic: What would you do?

Approximately 20% of the Department's fire responses involve motor vehicles. Although the majority of these incidents are easily resolved, all possess the potential for disaster. The purpose of this bulletin is to assist members in the safe handling of motor vehicle fires and associated hazards.

STRATEGY/TACTICS

The following are considerations to be included in proper size-up and implementation of tactics.

Apparatus Placement

1. Uphill - Avoids accidental contact with hazardous/flammable liquids and vapors. Facilitates advancing lines and equipment. Provides protection against runaway vehicles.
2. Upwind - Affords protection from hazardous vapors and reduces smoke in the work area.
3. Personnel Protection - Apparatus can be utilized to shield the work area from traffic hazards. Improves equipment access. Creates a safe work area taking into consideration the potential for fuel tank rupture.
4. Warning Devices - Utilization of cones for safety. Use of apparatus warning lights adhering to Department policy. Use of apparatus lights to illuminate work area. Judicious use of flares avoiding accidental involvement as ignition source. CAUTION: California Highway Patrol research has indicated that the use of excessive warning lights may cause focus fixation, particularly in drunk drivers.

Water Supply - If the water carried on the responding apparatus will not be sufficient, early consideration must be given to additional water supply sources. Possible additional sources include: additional apparatus, hydrants, pools, reservoirs, water tank trucks, utilization of aerial ladder to improvise a standpipe to reach freeways. Direct additional responding apparatus to facilitate access and minimize response time.

Vehicle Involvement

1. Engine Compartment

- A. Access - Interior/exterior hood release. Preplan release mechanisms. Some vehicles employ an interior primary release with a secondary release located under the hood and accessible only after activating the primary release. If the interior release (usually made of plastic) is destroyed by fire, search the general fire wall area under the dashboard for a bare cable. Pulling this cable with channel lock pliers will usually release the hood. Other release levers may be located in grill area, near front bumper, etc. Many late model vehicles have plastic grills that can easily be removed allowing faster location of release mechanisms. Use hayward or crowbar to prop hood open as this will protect against spring failure.
- B. Battery - Explosion hazard due to presence of hydrogen vapors. This hazard is increased when combined with a source of ignition, heat from fire, hot weather or severe operating conditions. ALWAYS WEAR SAFETY GOGGLES, IF NOT WEARING SCBA FACE PIECE, WHEN WORKING IN ENGINE COMPARTMENT. When safe, always disconnect battery ground cable first. The ground cable can be identified as the one attached to the vehicle body/frame. Avoid contact with battery acid.
- C. Vapor Canister - Control of emissions from evaporation of fuel has been required in car models since 1970. Fuel vapors which would otherwise escape to the atmosphere are directed to a vapor canister. The carbon in the canister absorbs the vapors and stores them. The vapor is removed from the canister during periods of engine operation as manifold vacuum draws the vapors into the engine and burns them. This canister is most often located in the lower, forward portion of the engine compartment, but in some cases, may be located in one of the front wheel wells. Rupture of the canister may release flammable vapors.
- D. Catalytic Converter - An exhaust emission control device located in the vehicle exhaust system just ahead of the muffler. The converter uses catalysts to chemically convert undesirable exhaust emissions into less harmful emissions. Catalytic converters can achieve temperatures high enough to ignite ordinary combustibles that it may contact.
- E. Air Conditioners - Freon gas used in air conditioners is under pressure and may emit the toxic gases phosgene and fluoride if heated to the point of decomposition.

F. Electric Fans - Many late model vehicles employ electric fans to assist in engine cooling. These fans are controlled by a thermostat and activate at predetermined engine temperatures. Caution must be exercised to avoid injury due to the unexpected activation of the cooling fan.

G. Fuel Related Problems - Fuel system malfunction is a leading cause of fires in the engine compartment. The common scenario involves a fuel line rupture with the fuel pump continuing to operate, causing fuel to come in contact with any number of ignition sources within the engine compartment. In order to extinguish the resultant fire, the fuel source must be eliminated. This can be accomplished by crimping the fuel line and/or deactivating the fuel pump.

H. Engine Components - Plastic and combustible metals are used in numerous engine components. For a discussion of the hazards involved, see "Materials of Construction" on page 9.

2. Passenger Area

A. Electrical - Computer technology has found its way into automobile instrumentation. The modern automotive dash incorporates digital displays for vehicle monitoring tasks. For fires involving dash instrumentation, disconnect the electrical power and treat as a Class A fire. However, applying an extinguishing agent in the dashboard area without causing extensive damage is difficult. Every effort should be made to identify and isolate the fire area.

B. Upholstery - The interior passenger area is more a contributing factor to the spread of fire and a source of toxic smoke rather than an ignition factor. Upholstery components provide an abundant fire load. Fires involving upholstery areas require extensive overhaul. The area must be well ventilated. Breathing apparatus shall be used when ventilation is inadequate or impractical.

3. Trunk/Cargo Area

Trunk/hatch hold open devices may employ, alone or in combination, any of the following: springs, inert gas piston cylinders, extending arms, etc. When exposed to heat, failure or rupture of these devices should be expected. Excessive pressure may develop in lift assists causing a trunk or hood to fly open with explosive force when the latch mechanism is released. Ensure personal safety by allowing adequate clearance when releasing latches. Preplan various vehicle operations used to gain entry. Entry to trunk/cargo area may be by a lock/key mechanism or by an interior cable release similar to hood release mechanisms.

NOTE: Fires and incidents involving the trunk/cargo area are usually related to materials carried therein. As a consequence, firefighters must exercise extreme caution when addressing trunk/cargo area incidents. Storage area contents may involve toxic, flammable, corrosive or other hazardous materials. Expect the worst! Avoid complacency!

4. Vehicle Exterior

A. Energy Absorbing Bumpers

Hydraulic - Consists of a gas chamber filled with a mixture of inert, non-flammable nitrogen/helium gas pressurized to 150 PSI and a hydraulic fluid chamber which is filled with a petroleum based fluid. These two chambers are separated by a floating piston. Bumper travel is up to three inches.

Mechanical - Employs a heavy spring to absorb impact. These units travel up to 4 inches

Hazards - A jammed bumper suddenly returning to original position. Avoid the use of a cutting torch on hydraulic units to preclude possible ignition and injury. Unusually high pressure developing from fire conditions may result in the sudden release of the bumper assembly causing serious injury to personnel. At an incident in the valley, a bumper assembly traveled a distance of 25 feet (see photos).

CAUTION: The safe deployment of apparatus and personnel must allow for the possible release of vehicle bumper assemblies.

NO PICTURE

Vehicle after release of bumper assembly.

NO PICTURE

Bumper assembly which failed under severe fire exposure and traveled a horizontal distance of approximately 25 feet.

- B. Tire Fires - Overheated brakes and/or underinflation are the usual causes of tire fires. Normally of little threat, a tire fire can extend into the cargo, passenger, and engine compartments. Large quantities of water are required for cooling and extinguishment. Tire fires may involve combustible metal components (see page 9 for more information).

CAUTION: Tires exposed to fire may explode causing vehicle to drop suddenly.

- C. Window Glass - In many auto incidents it becomes necessary to break window glass. This can be accomplished by striking the glass in a corner. Most auto glass is tempered and will break out in small chips. The exception is the front windshield, which should be safety glass-. Beware of tinted glass as it has the ability to camouflage a smoke filled vehicle.

Lock Outs - Frequently, the Department responds to incidents involving small children locked inside vehicles. Remember, interior vehicle temperatures can vary considerably from exterior temperatures. If initial efforts to gain entry are not successful, don't hesitate to break window glass.

- D. Fuel Tanks

Metal - Sheet metal with crimped and welded seams

Plastic - Molded high-density polyethylene or similar material.

Fill pipe is integral with metal tanks and has a soldered joint on most models. Some have neoprene hose couplings. Gasoline vent lines have neoprene hose connecting them to tank.

Gasoline cap - Emission control caps are a sealed unit with a pressure/vacuum relief valve that allows air to enter the gasoline tank as gasoline is used, and also vents excess pressure to the atmosphere. The pressure/vacuum relief valve in most caps has a plastic disc which, if melted from heat, could cause valve malfunction by plugging the vent. If fire is impinging on fuel tank, consideration should be given to possibility of rupture.

-- DO NOT REMOVE THE GAS CAP --

Removing the gas cap from a fuel tank, under heat and pressure conditions, could result in a reflash or explosion. The vast majority of cars have fuel tanks located at the rear of the vehicle. The most severe casualties, in terms of loss of life and property, occur from fires following rear end collisions.

E. Fuel Leaks/Spills

<i>GASOLINE:</i>	Flash point:	- 45oF
	Specific Gravity:	0.8
	Water Soluble:	No
DIESEL #2	Flash Point:	125oF
	Specific Gravity	Less than 1.0
	Water Soluble:	No

Whether a vehicle fire or traffic accident, most incidents involve a fuel leak or spill of some quantity. It is important to understand the basic properties of vehicle fuel (listed above). This knowledge will assist members in formulating proper strategy and tactics. Following are some general recommendations.

1. Spot apparatus safely: Uphill and upwind to allow sufficient distance in case fuel spill ignites.
2. Position hose lines and dry chemical extinguisher as necessary.
3. Eliminate ignition sources: Avoid the use of road flares. Disconnect battery (ground cable first). Use traffic cones.
4. Determine location of leak and attempt to stop the fuel flow. Maintain assortment of plugs, golf tees, sealants, etc. to address various types of leaks.
5. Adhere to the following practice when handling fuel spills:

Containment: If appropriate, containment should be initiated to prevent fuel from entering drainage system. Methods may utilize sawdust, sand, plastic, etc. Large spills may require additional assistance obtained through OCD.

Absorption: Small spills can be eliminated utilizing sand, sawdust, etc. for absorption. Remember, the absorbed material must be properly disposed. Contact OCD to request response of City Street Maintenance or appropriate agency.

Dilution: NEVER wash fuel spills into storm drains. If fuel has already entered the drainage system, attempt to dilute the product by flushing with copious amounts of water. Make proper notifications through OCD. Additional information can be found in Manual of Operation Volume I, Section 2/1-49.27.

SAFETY CONSIDERATIONS

Vehicle Stability

Take initial action to ensure control over vehicle movement. Use chock blocks, equipment lines, etc. to prevent unexpected movement during firefighting operations.

1-1/2" Line/Dry Chemical Extinguisher

Standard operating procedure involves the minimum deployment of a 1-1/2" hose line for fire suppression and a dry chemical extinguisher for personnel protection. The member stationed on the dry chemical extinguisher must allow sufficient distance in order to initiate protective/rescue measures should the incident escalate endangering the hose line operator or other civilian and rescue personnel on scene. When possible, position dry chemical extinguisher on windward side of vehicle. The effective range of a 20 pound extinguisher is 15 to 20 feet.

Backdraft/Flashover

Backdraft: Explosion resulting from the introduction of oxygen into a confined space/area that is both pressurized with heated flammable gases and deficient in oxygen.

Flashover: Sudden ignition of combustible gases and/or combustible surfaces in an involved area resulting in a sudden and intense rise in temperature.

These two hazards are NOT limited to structure fires. A firefighter was recently burned from a backdraft explosion emanating from the interior of a VW van. Conditions fostering flashover or backdraft can be present at incidents involving vehicle fires. Caution must be exercised when accessing ALL confined and/or involved vehicle areas. A charged 1-1/2" hose line must be an integral component of entry when fire is suspected. Have the hose line charged and ready before making entry. The potential for backdraft can be reduced through cross ventilation of the vehicle by breaking out windows.

BLEVE - Boiling Liquid Expanding Vapor Explosion

Always a consideration given the combination of liquid (fuel) in a container (fuel tank) exposed to heat (vehicle fire). Cooling the fuel tank is an advisable safety precaution if fire impingement on the tank is suspected. Do not allow water to enter the fuel tank as this may cause fuel to overflow from the tank creating an additional hazard.

The hazard of a BLEVE is an important consideration when addressing fires in vehicles utilizing Liquified Petroleum Gases (LPG). These vehicles are readily recognized by the presence of the LPG storage tank and associated piping. Additionally, identifying signs are usually found on the vehicle exterior. Consider the following when dealing with LPG vehicle incident:

1. The LPG storage cylinder is usually found on the exterior of the vehicle on either side or the rear. The storage tank may be found in the vehicle interior if properly sealed and separated from passenger compartment.
2. Flow of LPG through piping can be controlled by closing valves found on the storage cylinder. These valves may be identified with appropriate signs.
3. A pressure relief valve is required at the storage cylinder. Allow the relief valve to operate as designed. If the vapors coming from the relief valve have been ignited, allow the LPG to burn and protect exposures.
4. If fire is impinging on the LPG storage cylinder, take action to control the fire and cool the cylinder.

CAUTION: Too many variables are involved to allow accurate BLEVE predictions. Recorded BLEVES have occurred within 10 minutes of fire exposure. Ensure safety of personnel and operations at all times.

Remember the properties of LPG when considering tactics. LPG is heavier than air. It tends to settle into low lying and confined areas such as garages. The vapor cloud is visible but cannot be used to accurately define flammable perimeters. Vapors can flashover the entire confined area if ignited. Vapor clouds can be dispersed using fog streams.

Materials of Construction

1. Plastics

The automobile industry, striving to improve fuel economy through vehicle weight reduction, is expanding the applications for plastics in vehicle components. Plastics are even utilized as engine parts, exterior body panels and engine covers (i.e., Pontiac Fiero, Honda CRX). Fires involving vehicles will produce a number of toxic gases emanating from plastic components. Following is a list of some of these toxic gases.

Ammonia	Hydrogen Chloride	Nitrogen dioxide
Carbon Dioxide	Hydrogen Cyanide	Nitric oxide
Carbon Monoxide	Hydrogen Sulfide	Sulfur Dioxide
Acetic Acid	Acetic Anhydride	Formaldehyde
Acetaldehyde	Acrolein	Formic Acid
Furfural		

During firefighting operations, familiar odors and characteristics may be partially/totally "masked" by the cumulative presence of many toxic and/or non-toxic products of combustion, thereby eliminating any possible sensory perception.

-- WEAR SELF-CONTAINED BREATHING APPARATUS --

Inhalation of toxic gases must be avoided. Self-contained breathing apparatus shall be utilized whenever the presence of toxic gases is suspected.

2. Combustible Metals

Some vehicles have various parts constructed of combustible metals, such as engine blocks, heads, wheels, headlight casings, etc. These metals are normally an alloy of aluminum and magnesium. Most of the so called "mag" wheels are an aluminum alloy and do not contain magnesium.

Combustible metal fires present special problems. Magnesium combines so readily with oxygen that under some conditions, water that is used as the extinguishing agent may be decomposed into its constituent elements of oxygen and hydrogen. The released hydrogen will add to the intensity of the fire. However, large amounts of water applied to solid combustible metal fires will cool the metal below its ignition temperature. After some initial intensification, the fire should go out.

NOTE: Take caution to avoid burns from splattering when water initially contacts burning metal.

Like plastics, the use of combustible metal in vehicle components is on the increase. Expect to find applications in diverse vehicle body locations.

VEHICLE EXTRICATION

An incident involving extrication of victims from a vehicle requires creative tactics and timely action. Safety is of paramount importance. The first arriving fire company/rescue ambulance must control operations maintaining safety for personnel and victims at all times. The following guidelines should be considered when developing proper strategy/tactics at extrication incidents:

1. A safe 30' minimum working area must be established. Spot apparatus as discussed under "Apparatus Placement". Allow for Rescue Ambulance access and subsequent departure with victim. Initial apparatus placement must take into consideration the commitment of additional apparatus (Heavy Utility) or specialized equipment (jaws).
2. The first arriving Engine Company shall, as a minimum, deploy and maintain throughout the duration of the incident, a charged 1-1/2" hose line with dry chemical extinguisher as backup.
3. Stabilize the vehicle prior to initiating extrication to preclude movement during subsequent operations. Various equipment can be utilized: blocks (cribbing), cables, jacks, lifelines, etc.
 4. Victim stabilization - The victim in the vehicle can be stabilized once personnel safety and control of the incident have been ensured.
 5. The Engine Company Captain will normally assume the role of Safety Officer. This officer will also control access to the work area excluding unauthorized/unnecessary personnel whether they be fire, EMS, police, news media or civilian. Use police assistance when necessary.
 6. EMS personnel treating the trapped victim shall wear protective clothing per Department policy.
 7. Extrication incidents requiring the use of specialized equipment such as the jaws or porta-power merit special consideration. Extrication is facilitated when proper access is provided for, the equipment and personnel. The following is an example of POSSIBLE designated responsibilities for individual task force members utilizing the jaws rescue tool.

Captain II: Incident Commander

Apparatus Operator: Truck placement, evaluates extrication alternatives, operates jaws.

Tillerman: Verify vehicle stabilization, patient stabilization, sets up lights if needed.

Truck Firefighter: Placement of jaws tool and accessories; operates jaws power unit.

Truck Firefighter: Placement of jaws tool and accessories; light placement; assist A/O.

Captain I: Safety Officer; establish and maintain minimum 30' working area; deploy 1-1/2" hose line and dry chemical extinguisher.

Engine Firefighters: Manage 1-1/2" hose line and dry chemical extinguisher.

Engineers: Traffic control and secondary water supply.

This example is provided to stimulate discussion.

Extrication incidents demand creativity, discipline and flexibility. Our objective as emergency responders is to be a part of the solution, not part of the problem.