Knowledge Objectives (1 of 3)

- Describe the investigative techniques used to analyze a vehicle fire.
- Discuss safety issues surrounding vehicle fire investigation.
- Identify the fire fuels present in vehicles.

Knowledge Objectives (2 of 3)

- Identify potential ignition sources present in vehicles.
- Discuss the various vehicle systems and components with relation to fire cause.
- Discuss the body systems in a vehicle and how they may affect a vehicle fire.

Knowledge Objectives (3 of 3)

- Explain how to document a vehicle fire scene.
- Discuss the process used in the examination of a vehicle fire.
- Explain special considerations for various types of vehicles and equipment.

Skills Objectives

- Conduct a vehicle fire investigation.

Introduction

- Vehicle fire investigation is often considered complex.
- Actually, investigation is the same as for other fires
  - Same requirements for successful ignition and propagation
Investigative Techniques

• Investigators should learn general systems and characteristics of vehicles
  – Before conducting vehicle investigation
• Most mobile equipment uses similar mechanical systems.
• During initial phase of investigation, look for fire or damage patterns inside or outside the vehicle

Vehicle Investigation Safety (1 of 2)

• Support and stabilize vehicle when inspecting undercarriage
• Be aware of undeployed airbags.
  – They may deploy unexpectedly.
• Electrical systems in hybrid or electric vehicles
  – Potential shock hazard
• RVs may have “shore power” connection

Vehicle Investigation Safety (2 of 2)

• Other hazards:
  – Possibility of fuel spillage
  – Contamination with coolants, lubricants, or other fluids
  – Cut and puncture hazards
  – Release of energy from damaged spring devices

Vehicle Fire Fuels

• Liquid fuels
  – Engine fuels, lubricants
  – Transmission fluid, power steering fluid
  – Hydraulic or cargo fluids
• Gaseous fuels (propane, natural gas)
• Solid fuels (wiring insulation, plastics, etc.)
• Presence of melted metals is not an indicator of the use of an ignitable liquid

Ignition Sources

• Generally same as in structural fires
• But some are unique to vehicles
  – Exhaust components
  – Braking system components

Open Flames

• Most modern vehicles have fuel injection systems
  – No carburetor fires
• Smoking materials
• Range appliances
• Outside sources
Electrical Sources (1 of 4)

- Battery
  - Some vehicles have multiple batteries.
- Resistance heating
  - Overloaded wiring
  - Arcing from damaged wires and crushed batteries
  - Broken bulbs
  - External ignition sources

Electrical Sources (2 of 4)

- Battery is primary source of electrical energy in a vehicle that is not running
- Fuses, circuit breakers, or fusible links protect the electrical circuits in most vehicles.

Electrical Sources (3 of 4)

- Some RVs have multiple batteries and connection to an outside power.

Electrical Sources (4 of 4)

- Aftermarket equipment
  - May be improperly installed
  - May lack overcurrent protection
  - Typical culprit for resistance heating
    - Audio and video systems
    - Enhanced vehicle lighting
    - Navigation systems

Hot Surfaces (1 of 2)

- Hot exhaust system components
  - Leaking engine oil, power steering fluid, brake fluid may ignite on contact
- Factors include:
  - Ventilation
  - Autoignition point
  - Liquid vaporization rate
  - Atomization of the liquid
  - Length of exposure

Hot Surfaces (2 of 2)

- Catalytic converters
  - May reach higher-than-normal temperatures under heavy loads
  - Ceramic matrix material inside may melt and be ejected from the tailpipe
Mechanical Sparks

- Metal-to-metal contact due to:
  - Rotating equipment
  - Bearings
- Metal-to-pavement contact
- Farm, logging, construction, or highway maintenance equipment
  - Friction between mechanical attachment and cellulosic crop may cause sparks

Smoking Materials

- Improperly discarded or misused smoking materials are potential ignition source

Systems and Their Function in a Vehicle

- Fire investigator should understand various systems
- Information can be found at
  - Library
  - Car dealership service department
  - Parts supplier

Fuel Systems (1 of 4)

- Vacuum/low-pressure carbureted systems
  - Older automobiles
  - Gasoline-powered farm equipment
  - Lawn vehicles
  - Stationary equipment

Fuel Systems (2 of 4)

- High-pressure fuel-injected systems
  - Seen on modern cars
  - Fuel is pumped to single venture-mounted fuel injector (throttle body) or to a fuel rail assembly

Fuel Systems (3 of 4)

- Diesel fuel systems
  - Often use two pumps
  - Combustion air is provided through a turbocharger
- Natural gas and propane fuel systems
  - Leaks found after a fire might not be indicative of prefire leaks
Fuel Systems (4 of 4)

- Turbochargers
  - Increase power of engine by forcing pressurized air into cylinders

Emission Control Systems

- Reduce or control exhaust gas emissions
- Collect gasoline vapors while engine is operating
- Problems:
  - Vapor leaks
  - Ignition of undercoating, carpeting, and external combustibles
  - Ejection of hot particles from exhaust

Motor Vehicle Electrical Systems (1 of 2)

- The storage battery is the primary energy source in a vehicle.
- The conductor size determines the amount of electrical energy the system can safely carry.
- Potential causes of fire:
  - Arcing on the conductors
  - Ignition of hydrogen

Motor Vehicle Electrical Systems (2 of 2)

- Types:
  - 12-volt electrical systems
  - More rarely, 6- or 24-volt systems
  - 120-volt and 12-volt on RVs
- Investigator can obtain useful information:
  - Event data recorders
  - Electronic control module (ECM) on diesels
  - Wireless communications and tracking systems

Mechanical Power Systems

- Internal combustion engine failures
  - Failure of bearings, rings, pistons
  - Leaks from lubrication systems and liquid cooling systems
  - Belt breaking in air-cooled system

Mechanical Power Distribution

- Mechanically geared transmissions
  - Power is transferred through the clutch assembly
  - A leak of transmission fluid may lead to fire.
- Hydraulically actuated transmissions
  - Transmission fluid is cooled by routing through the radiator or by auxiliary heat exchangers
  - If transmission fluid contacts heated exhaust components, a fire may result.
Accessories and Braking Systems

(1 of 2)

- Mechanical failures may occur in:
  - Alternators
  - Air conditioning compressors
  - Power steering pumps
  - Air pumps, vacuum pumps

Accessories and Braking Systems

(2 of 2)

- Failures in these systems may present ignition sources.
  - Mechanical failures that produce friction
  - Leaks in hydraulic brake systems that spray ignitable vapors
  - Brake system malfunctions that produce more heat than can be safely transferred to the air

Body Systems

- Contain many combustible materials
- Contribute to fuel load once fire has begun
  - Interior finishes and accessories
  - Cargo areas
    - Investigate contents.

Documenting Motor Vehicle Fire Scenes

(1 of 4)

- Same procedures used for documenting a structural fire scene
- Vehicle identification
  - Make, model, and year
  - Vehicle identification number (VIN)

Documenting Motor Vehicle Fire Scenes

(2 of 4)

- Vehicle fire scene history
  - Conduct interviews
  - Obtain:
    - Last use of vehicle and by whom
    - Mileage at the time of the fire
    - Operation problems
    - Service or maintenance history
    - Fuel level and type, when last fueled and where
    - Equipment and personal effects in each area
    - Photos or videos prior to, during, or after the fire

Documenting Motor Vehicle Fire Scenes

(3 of 4)

- Inspect an exemplar vehicle.
- Documenting the scene
  - Make a scene diagram
  - Take photos in systematic manner
  - Take precautions before the vehicle is towed to a controlled setting.
    - Wrap damaged portions to prevent evidence from dropping en route.
    - Protect vehicle from the elements.
Documenting Motor Vehicle Fire Scenes (4 of 4)
• Documenting away from the scene
  – Date and time of loss
  – Location of loss
  – Names or operator, passengers
  – Witness statements, police and fire reports
  – Vehicle’s current location and method of transportation
  – Missing or damaged parts

Motor Vehicle Examinations (1 of 3)
• Best done after removal from scene
• Notify interested parties before destructive examination
• Determine area of origin.
  – Exterior damage patterns

Motor Vehicle Examinations (2 of 3)
• Divide the investigation:
  – Engine compartment
  – Passenger and driver areas
  – Cargo space
• Systematic inspection
• Include position of switches, handles, and levers

Motor Vehicle Examinations (3 of 3)
Table 23-6 Windshield Indicators of First Involvement

<table>
<thead>
<tr>
<th>Compartment</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger</td>
<td>Top of the windshield fails</td>
</tr>
<tr>
<td></td>
<td>Radial burn patterns on the hood</td>
</tr>
<tr>
<td>Engine</td>
<td>Bottom of the windshield fails</td>
</tr>
<tr>
<td></td>
<td>Radial patterns on the doors</td>
</tr>
</tbody>
</table>

Additional Vehicle Considerations (1 of 3)
• Total burns
  – Condition prior to fire/missing components
  – Ignitable liquids on floorboard
  – Remaining fluids in systems
• Stolen vehicles
  – The chance that the fire was accidental is low
• Vehicles in structures
  – Potential ignition source until hypothesis is eliminated

Additional Vehicle Considerations (2 of 3)
• Recreational vehicles
  – Make sure confined spaces do not contain hazardous levels of explosive or toxic vapors
  – Use appropriate PPE.
  – Be aware of electric hazards.
  – Be aware of the potential presence of fuels.
  – Evaluate potential stability hazards.
Additional Vehicle Considerations (3 of 3)

- Recreational vehicles (cont’d)
  - Consider the unique systems and components of RVs
  - If appliances are involved, obtain type, brand, model, and condition
    - Obtain service and recall history
    - Interview users for history of malfunction or replacement
    - Gain information from web sites and RV dealers

Heavy Equipment

- Earth-moving, construction, mining, forestry, landfill, and agricultural equipment
- Medium- and heavy-duty trucks and buses
- Mass transit vehicles
- Susceptible to failure:
  - Overloading the engine or transmission
  - Failure of hydraulic or electrical systems; failures of bearing or engine
  - Unintended ignition of materials

Agricultural Equipment

- Subject to cellulosic material accumulation
  - Grain dust, wheat or corn chaff, straw, etc.
- Fires may also result from:
  - Electrical, fuel, hydraulic systems may fail
  - Friction from bearing failures.
  - Sparks from foreign metals in the field.
  - Friction/sparks from filed mechanical parts
- Routine maintenance is required.

Hybrid Vehicles and Inspection Safety

- Dangerously high voltages
  - Use caution in approaching.
- Wiring with over 60-V DC or 30-V AC is orange in color, indicating potentially lethal hazard.
- Obtain product-specific information.
- After positive isolation of high-voltage system, proceed as for any other vehicle

Summary (1 of 5)

- Fires in vehicles have the same basic requirements for successful ignition and propagation as other fires.
- Investigators should learn the general systems and characteristics of vehicles.
- Take care to support and stabilize the vehicle properly while inspecting the vehicle’s undercarriage.

Summary (2 of 5)

- Liquid, gaseous, and solid fuels are involved in vehicle fires.
- Vehicles have some unique ignition sources, including heated exhaust components, various types of bearings, and braking systems.
Summary (3 of 5)

- Document the vehicle at the fire scene, following the same procedures used for a structural fire scene.
- A more complete examination of the vehicle is best accomplished after removal from the fire scene.

Summary (4 of 5)

- There is always information to be retrieved, even after a total burn fire.
- When a vehicle is located in a structure where a fire has occurred, consider the vehicle a potential ignition source.

Summary (5 of 5)

- Assistance from an electrical or mechanical engineer could be indicated in evaluating a recreational vehicle's heating and electrical systems.
- Large equipment is often diesel powered with a hydraulic transmission. These systems are sometimes susceptible to failure.