Firefighter Guidance Note 6-19: Alternative Fuel Vehicle Safety

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Background

An alternative fuel vehicle (AFV) is a vehicle that runs on any other fuel other than traditional petroleum-based fossil fuels.

For the purpose of this Guidance Note, the focus will be placed on Hybrid-electric, Electric and Hydrogen Fuel Cell vehicles (HFCV). As more AFV’s emerge and become available, this Guidance Note will be updated to reflect this.

AFV’s can be powered by a combination of internal combustion and electric motors. The electric motors are powered by high voltage battery packs.

HFCV’s produce electricity through an onboard hydrogen fuel cell reactor, and the electricity is then supplied to the vehicle’s electric motors. Excess energy is stored in high voltage battery packs.

An HFCV uses the same kind of electric motor to turn the wheels that a hybrid-electric or electric car does, but without the use of high voltage battery packs.

An HFCV is powered by a fuel-cell stack in which pure hydrogen (H2) passes through a membrane to combine with oxygen (O2) from the air, producing electricity and water vapor. Hydrogen high-pressure tanks are designed to survive even the highest-speed crashes without leaking or breaching.

The HFCV's may have high voltage battery packs, and the stored energy in these battery packs is created by vehicle de-acceleration or braking. This stored energy is utilized for extra power during short acceleration events, and to smooth out the power delivered from the fuel cell with the option to idle or turn off the fuel cell during low power needs.

Concerns/hazards

Although manufacturers build many safety features and devices into their vehicles to prevent accidental shock to the driver, AFV's high voltage system can pose a shock hazard to firefighters in an emergency situation.

Actions for employers

Employers must:

- familiarize firefighters with the hazards of responding to AFV related incidents

Employers should:

- train firefighters on the means provided by manufacturers to shut down AFVs
- develop a policy or standard response guideline for AFV related incidents

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Safety considerations

These are some important safety considerations for AFV

Fires

AFV's can experience multiple classes of fires:

- Class A — Ordinary combustibles (for example, wood, fabrics and some plastics)
- Class B — Flammable liquids (for example, gasoline)
- Class C — Live electrical equipment (for example, wiring and batteries)
- Class D — Combustible metal (for example, magnesium)

Battery fires may initially show from under the vehicle.

Visible flames may not be present when hydrogen is burning or suspected to be burning. Thermal imaging technology should be utilized when dealing with these types of AFV related incidents.

Quiet operation of vehicle

The AFV's may still be powered on even though there may be no engine noise. This poses a risk of the vehicle accidentally moving. AFV's may move silently, never assume it is powered off and it will not move.

Hydrogen vehicles use high pressure vessels to store fuel which may have pressures as high as 10,000psi/700 bar.

Pre-incident planning

The employer should consider the following, during pre-incident planning:

- Safety considerations noted above need to be included in planning
- incidents may be a combined fire, extrication and hazmat incident

- develop guidelines for the extrication of people from AFVs, including fire safety considerations
- develop guidelines for when crews should have limited interaction and allow the vehicle to burn (such as, defensive tactics)
- increased time may be required to manage and control AFV’s fires
- during call taking, have dispatch assess whether an AFV’s is involved and whether it is near a structure (home, garage and parking garage)
- markings to indicate AFV’s vary
- the location of high voltage cables varies, there may be high voltage cables in the cut zones
- understand and identify where high-pressure tanks and fuel lines are within the vehicle

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Incident actions

The employer should consider the following when responding to an AFV incident:

- heightened situational awareness must be maintained while working on roads for extended periods of time
- park fire apparatus uphill and upwind
- high voltage systems need to be shut down before entering damaged hybrid or electric vehicles, or before starting extrication procedures
- wear full PPE with SCBA with face-piece
- use a thermal imaging camera to assess AFV hazards, such as:
    - if there is a fire, and the extent of the fire
    - if it is a compartment fire
    - if the fire includes the electric components of the vehicle
- use an air monitoring device to detect spikes of carbon monoxide
- secure the electric vehicle, where possible, by:
    - putting the vehicle in park
    - turning the vehicle off

    - chocking the wheels

The best method for managing or controlling a battery fire is with large quantities of water. Secure a large, continuous, and sustainable water supply

For fire involving Hydrogen, the North American Emergency Response Guide should be utilized.

Secondary ignition risk

The heat from the fire may have damaged additional cells which may require additional suppression activities. Batteries should always be treated as energized.

Following initial suppression activities, monitor for:

- heat from the battery
- possible secondary ignition

Have sufficient fire personnel and apparatus on scene for an extended operation.

Safety during overhaul

Supervisors should consider the following during overhaul:

- SCBAs should be utilized during overhaul
- do not make contact with any high voltage components
- a high voltage cable may run under the vehicle chassis, posing a shock hazard when cutting into, lifting or stabilizing hybrid or electric vehicles — the **high voltage cable** should not be cut, disconnected or handled due to the shock hazard
- high voltage systems need to be shut down before entering damaged hybrid or electric vehicles
- there may be residual power in other batteries or other energy sources

Stabilizing and cutting the vehicle

Consider the following when stabilizing and cutting into an AFV:

- vehicle construction and weight distribution could change standard strategies for stabilization
- for rescue struts, **do not** use any holes that may have been caused by the crash and **do not** pierce, puncture or create any purchase point in the battery case — this could cause an electrocution and/or fire hazard
- the battery compartment may form part of the structure — consider this when determining how to extricate
- remove trim to verify what is being cut before the cut is made
- **do not** cut any high-voltage cabling

Air quality

Consider the following to ensure safe air quality:

- harmful/flammable gasses may be released from batteries and may cause eye, nose or throat irritation — wear full PPE, including SCBA
- using a vent fan may be appropriate to blow fresh air into the passenger compartment of the vehicle

Lifting the vehicle

Consider the following when lifting an AFV:

- lift vehicles using the appropriate lift points

After an incident

Thermal events with the battery system could continue for some time after the initial incident. To keep workers safe, consider the following:

- batteries should always be treated as energized and pose an ongoing risk
- have the fire apparatus escort the vehicle to the recovery location, if possible
- inform fire investigators of the hazards of the AFV
- inform tow truck drivers of the potential to re-energize the battery depending on tow method, if possible

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Applicable regulations and acts

To learn more about the applicable regulations acts you can read:

- *Occupational Health and Safety Act*
    - clause 25(2)(a) for providing information and instruction to a worker
    - clause 25(2)(d) for making workers aware of hazards
    - clause 25(2)(h) for taking every precaution reasonable in the circumstances to protect workers

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Related

Firefighter's Cancer Prevention Checklist

Read NFPA 921 Guide for Fire and Explosion Investigations for safety during post-response investigation, arson investigation and vehicle investigation.

As part of the Electric Vehicle Safety Training project, the National Fire Protection Association (NFPA) is working with vehicle manufacturers to help inform fire services and other first responders about hazards associated with electric vehicles. This information may be found in NFPA - Emergency Response Guides for Alternative Fuel Vehicles for specific vehicle types.

First Responders | Tesla

https://tc.canada.ca/en/dangerous-goods/canutec/emergency-response-guidebook