DORSET & WILTSHIRE FIRE AND RESCUE

DORSET & WILTSHIRE FIRE AND RESCUE SERVICE SUPPORTING INFORMATION

Alternatively Powered Vehicles Further Information

To be used in conjunction with AHIS 19 Alternatively Powered Vehicles

Response

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Liquified Petroleum Gas (LPG)

LPG is stored pressurised in cylinders. Often part of the boot space of the vehicle or the spare tyre is sacrificed. There is no requirement for an LPG powered vehicle to be marked. LPG consists of mainly propane (C_3H_8), propene (C_3H_6) and butane (C_4H_{10}). A stenching agent is added. Any leaks will be highly flammable with a risk of explosion. LPG is also heavier than air so leaks will pool in low-lying areas. If the cylinder is heated directly a Boiling Liquid Expanding Vapour Explosion (BLEVE) with an associated catastrophic failure is a possibility. A pressure relief valve is fitted to correctly installed LPG fuelled vehicles. If the LPG cylinder is heating up the pressure relief valve may actuate in two ways: It can raise of its' seating, vent off and then re-seat. There will typically be a hissing noise with this which may pulse. It can blow if the pressure is increasing even more dangerously. This will be followed with a continuous louder noise of the escaping gas (which is likely to ignite). Any jet of flame can extend up to seven metres to the rear or to the rear side of the vehicle.

The picture below shows a well-installed LPG conversion. Non-factory fitted conversions may have been installed by unregulated mechanics and may be prone to fail earlier in a fire.

LPG Cylinder in Car Boot

Compressed Natural Gas (CNG)

Consists mostly of methane (CH_4) stored at a pressure of approximately 200 bar. CNG is lighter than air so any leaks will disperse rapidly. CNG is odourless with no stenching agent added. The hazards associated with CNG are very similar to those of LPG cylinders. Most often found in heavy goods delivery and public transport vehicles.

CNG Cylinder in Car Boot

Liquefied Natural Gas (LNG)

LNG powered vehicles use the same gas as CNG vehicles but it is stored in flasks at a pressure of 7 bar and a temperature of –160 C in order for it to remain as a liquid.

Due to the low temperature of the stored liquid, any leaks have a risk of causing severe cold burns and will evaporate rapidly to produce clouds of flammable gas.

The application of water to any un-ignited leaks will cause a violent reaction as the evaporation is forced.

LNG Cylinder

Hybrid Vehicles

A hybrid vehicle has a petrol engine backed up by an electric motor. The motor is powered by a bank of individual cells, normally stored in the rear of the vehicle, and operate together at voltages of up to 500V.

Any components or cabling that carries the high voltage is marked with the ‘lightening bolt’ symbol and coloured orange. These areas should not be cut and should not have any of the protective plastic casing removed.

Orange HV Cable.

High Voltage Hazard symbol

Engine of Hybrid Vehicle

If the high voltage battery pack is involved in fire there is a risk of the cells exploding with a release of potassium hydroxide (UN Number 1814) and/or sodium hydroxide (UN Number 1824). These chemicals are classed as corrosive.

Battery behind rear passenger seat.

HV Battery in hybrid vehicle boot.

Hybrid Vehicles

Identifying a hybrid essentially can be broken down into two methods:

Look for hybrid “badges” or logos.

The presence of a badge makes identification easy, however, do not assume that the lack of a badge means the vehicle is not hybrid, the Lexus RX400h is hybrid, the only marking is the "h" in the model name, and Nissan make a hybrid vehicle that has no markings at all.

Look for things a standard vehicle doesn't have, i.e. a large yellow or orange cable running through or under the vehicle, (DO NOT tamper with it). Unfortunately for us, some manufacturers cover up this cable to "protect" it. This said, there may be "high voltage" stickers or markings within the vehicle. Dashboard indicators are another good sign; look for voltage indicators and "ready" lights. Usually, the lack of a green light or the illuminated "ready" sign means that the primary power is turned off.

Or under the bonnet, the "engine bay" will not look like a standard petrol/diesel engine.

It is always wise to ask the vehicle owner, a mistake could prove costly.

High Voltage Batteries

The electrolyte, consisting of potassium and sodium hydroxide, is absorbed into cell plates to form a gel that shouldn't leak, even after a collision. If the battery is crushed, however, it is possible for electrolyte drops to leak. All hybrid models also use a 12-volt battery system to power low-voltage vehicle systems.

Most hybrid models have safety switches that automatically cut high-voltage power to the system when supplemental restraint systems are activated during a collision. If the system short circuits, a fuse will open and cut off high-voltage power from the battery. The positive and negative cables are isolated from the chassis to prevent any type of electrocution hazard from touching the chassis itself. The automatic shut downs only handle high voltage from the battery to the electric motors; the batteries themselves remain energized. The hybrid system is shut down when the ignition is turned off, the battery is disconnected or the high-voltage system fuse is removed.

Some battery models contain a boost converter that takes the DC power and coverts it to 650-volt AC power to run the electric motors. Testing has indicated that high-voltage systems can remain energized after being subjected to fire. Therefore avoid contact with high-voltage components and never attempt to disconnect any high-voltage connections.

Rescuers should also avoid contact with damaged battery packs and any electrolytes that may have been released. The damaged battery pack still could be energised and the electrolyte can cause skin/eye irritations and burns. Toyota, Lexus and Nissan ERGs contain information on how to neutralise a leak and first-aid treatments for electrolyte exposure.

Other Dangers

A hybrid vehicle can move even though the vehicle appears to be off. The engine will normally be shut down when the vehicle is idling. This could give the impression that the vehicle is off, creating a false sense of security.

Blocks should be used on the wheels to prevent any movement.

The "key" for a Prius is in the form of a fob, the fob only needs to be within 20 meters of the vehicle for the vehicle to be "live". After an RTC it could be anywhere in the vehicle, in the drivers pocket or have been thrown from the vehicle but still be within 20 metres. This situation means that the car could be started by pressing the "start" or "power" button which will allow 600volts to travel through the wiring.

Accidents and Extrications

There are no extrication techniques specific to hybrid vehicles, but operations must take into consideration the location of high-voltage components. Manufacturers have placed the high-voltage cables and batteries in locations that are not normally areas we would cut; however we should consider that a collision may have pushed high-voltage components close to necessary cut points. Due to this, "strip and rip" is <u>essential</u>.

At no time should we attempt to disconnect high-voltage components, touch damaged or broken orange cables, cut high-voltage lines, or touch a damaged battery. To ensure safety, always treat high-voltage cables as if they are live.

Hybrid vehicle manufacturers recommend one of two options to disable the high-voltage system. Either of these steps causes a relay to open and prevents power from the entering the rest of the high-voltage system. The first method — and the simplest — is to remove the

key from the ignition (bear in mind the issues we may have with “keys”) and disconnect the 12-volt battery. The second method, used if access to the ignition key is not a viable option, is to disconnect the 12-volt battery and to pull the high-voltage system fuse in the engine compartment fuse box. Because identification of the correct fuse may not be possible, the manufacturer recommendation is to pull all the fuses. (This is not the actual high-voltage line fuse; it's simply the fuse that powers the relay in the high-voltage system) be mindful that this will prevent any electrical item from working, seats, windows etc. Utilising the Crash Recovery System on the appliance MDT you may be able to identify the location of the fuse.

Fires

Water is the most suitable agent for extinguishment. Although applying water to a high-voltage electrical system seems counterintuitive, there is no risk of the electricity traveling up the water stream and electrocuting fire-fighting personnel. Although still dangerous, direct current power sources don't need a path to ground, unlike alternating currents. Rather, DC electricity follows a path out from the battery, along the electrical circuit and back to the battery. As such, the electrical current will not travel up the hose stream as is possible with a high-voltage AC power source. The danger of electrocution exists when fire-fighters accidentally place themselves into the electrical circuit by simultaneously touching the negative and positive side of the circuit with either their body or equipment. Manufacturers recommendations for dealing with overheating batteries or batteries that have been exposed to fire are to totally flood the compartment that they are stored in with water.

A standard offensive attack is recommended unless the NiMH battery pack is on fire. If this is the case, live-fire tests indicate that it is better to allow the battery to burn out rather than attempt to extinguish it. It's nearly impossible to get enough water directly onto the battery for extinguishment because the battery is encased in protective shell. The only real access for water to the battery pack is via the battery vent, and many vent designs hinder easy access for this. Allowing battery pack to burn out also negates hazmat concerns over the residual electrolytes. Always make sure that the battery pack is cooled down enough to prevent re-ignition before releasing the vehicle. Thermal-imaging cameras should be used to determine if the battery pack is cool.

Attempts should be made to control runoff as the NiMH battery has cancer-causing ingredients. If a defensive attack is warranted, pull back to a safe distance and use a water stream to protect exposures and control the path of smoke. If the situation doesn't allow for a defensive attack, such as a vehicle in a garage, alter your plan as needed.

High-voltage components never should be overhauled, as there is no guarantee that the system is de-energized. Safety systems can be rendered inoperable by the effects of fire. Live-fire tests indicate that these components can remain live after a vehicle has been subjected to fire.

One final area of concern for responders is submerged vehicles. Hybrid-vehicle manufacturers recommend removing the vehicle from the water and using standard disabling techniques. There is no risk of electric shock from touching the vehicle's body or framework in or out of the water. As with a vehicle out of the water, responders should not touch high-voltage components or cables. All of the Hybrid ERGs address vehicles in the water.

START/STOP system Ultra-capacitors in modern vehicle technology

Start-stop systems automatically shut down and restart the internal combustion engine to reduce fuel consumption and emissions; for instance when the vehicle stops at a traffic light. To engage an auto-stop the driver needs to put the transmission to idle and release the clutch. As soon the driver steps on the clutch again, the engine will restart and the vehicle

can continue driving. The start-stop system is only operational if certain parameters are correct, such as a sufficiently charged battery and the right operating temperature of the engine.

As an alternative, some manufacturers use an ultra-capacitor as the energy storage device to restart the engine. This design, known as E-Booster, covers the high-energy demand needed when restarting a diesel engine. Ultra-capacitors are able to store a hundred times more energy than a conventional capacitor and at least ten times more than a 12 volt battery with a high service life of a million charge cycles.

The problem with such ultra-capacitors is not the electrical danger (as they operate with only 5.2 volts) but the potential damage to the capacitor in the event of a collision or during extrication activities, as these capacitors contain the chemical Acetonitrile as a solvent. Acetonitrile (information available via the Emergency Response Guide) is highly flammable and harmful by inhalation, ingestion, and/or skin contact.

Emergency personnel need to exercise caution not to damage an ultra-capacitor while working on a vehicle with rescue tools. On vehicles currently available with this technology (Peugeot and Citroen vehicles with e-HDI engines) the ultra-capacitor is mounted in the left front wing area. The position of these capacitors, as well as some background information, can be found on the Crash Recovery System. If an existing ultra-capacitor has been damaged in the accident or the vehicle is involved in fire, personnel should take extra precautions when working in close proximity to the device. The manufacturer of the capacitor and of the vehicles advises responders to wear full personal protective equipment, including respiratory protection. Due to the small amount of solvent involved, if this is damaged prior to emergency services arrival then this should have dispersed to atmosphere.

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