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## TWISTS ON HYBRID-ELECTRIC VEHICLE TECHNOLOGY

With the cost of gasoline rising on a regular basis, the development of alternative-fueled vehicles is an increasingly important effort. Gasoline-electric hybrids remain the most common types of production alternative-fueled vehicles available, at least in North America.

Information found in this Advantage Online article will be covered in a new Live program I-CAR is developing, *Hybrid Electric And Alternative Fuel Vehicles (ALT02)*. Technical information you will gain in this program includes:

- protecting yourself and others when disconnecting high voltage on BAS, two-mode, and other hybrid electric vehicle applications.
- avoiding costly mistakes associated with incorrectly repairing many of the systems found on these vehicles.
- being able to perform thorough damage analysis on hybrid electric vehicles to ensure that proper replacement parts are ordered, other collision factors are considered, and on-time delivery is ensured.
- being able to identify and work safely around CNG and propane-fueled vehicles.
- getting an overview of the newest technology surrounding plug-in electric and fuel cell powered vehicles.

The content found in this training program would benefit:

- collision repair technicians.
- educators.
- insurance estimators.
- recyclers.

For the most part, gasoline-electric hybrids have remained unchanged since the introduction of the Honda Insight in 1999 and the Toyota Prius in the 2000 model year. Now, some gasoline-electric hybrids are featuring a twist on conventional hybrid system technologies. Two of these are the joint development of the two-mode hybrid system, and the belt alternator/starter (BAS) hybrid system.

To provide complete and accurate repairs, it is important that all collision industry professionals involved with the repair of these vehicles keep current with new vehicle technology. More importantly, understanding how these systems operate can help ensure working conditions that are as safe as possible.

### TWO-MODE SYSTEM

The two-mode hybrid system is a joint development by GM, Chrysler, Daimler, and BMW. This system is currently available with the 2008 Chevrolet Tahoe Hybrid,, GMC Yukon Hybrid, and 2009 Cadillac



Figure 1—The 2008 GMC Yukon Hybrid is available with the two-mode hybrid system.

Escalade hybrid vehicles (see Figure 1). The 2009 Chrysler Aspen Hybrid and Dodge Durango Hybrid are Chrysler versions of the system. BMW has introduced a Sport Activity Coupe concept vehicle, the X6, featuring the two-mode hybrid system.

Two-mode is actually a variant of Toyota's combination hybrid system, where propulsion can be delivered either by the internal combustion gasoline engine, the electric drive motors, or both. The term "two-mode" refers to the two different variations in propulsion when traveling at low speeds, such as city driving with light loads, and at higher speeds or when hauling heavy loads. Automatic transmission technology is used to shift between the modes much like a constantly variable transmission. Within an automatic transmission housing are two 60 kW electric motors/generators (compared to a large motor and a smaller motor with other combination hybrids),

three planetary gearsets, and four sets of clutches (see Figure 2). A 300-volt nickel-metal-hydride (NiMH) battery pack is used to store and provide high-voltage electrical energy.

At low speeds with lighter loads, propulsion comes from the electric motors. The internal combustion engine can restart instantly if needed. In this mode, one of the electric motors acts as a generator, while the other operates as a motor. At higher speeds such as highway driving, or heavier loads, the internal combustion engine provides the vehicle propulsion.

## BELT ALTERNATOR/STARTER SYSTEM

GM introduced a hybrid system called Belt Alternator/Starter (or BAS) in the 2007 Saturn Vue Green Line Hybrid (see Figure 3). This system is also available on the 2008 Saturn Aura Hybrid and the 2008 Chevrolet Malibu Hybrid. Like the start/stop system feature on most hybrid-electric vehicles, the BAS system shuts down the engine when the vehicle comes to a stop and instantly restarts it when the brake pedal is released.

With the BAS system, the alternator is replaced with a belt-driven electric motor that is connected to the crankshaft via a special drive belt. The motor serves as both a generator and motor. The electric motor only provides assist to the IC engine during acceleration, therefore is considered a mild hybrid system.

The BAS system fits in the same space as a conventional engine. No modifications to the conventional model chassis were required to accommodate the BAS system.

## CONCLUSION

Gasoline-electric hybrids continue to remain the most common types of alternate fueled vehicles available, and more and more models can be found on the road each year. Some late model hybrid vehicles are being introduced

with twists to the basic hybrid technologies.

More information on the new model hybrid vehicles is being assembled for a new I-CAR Live training program, Hybrid Electric And Alternative Fuel Vehicles (ALT02). This program will premiere at NACE then be available everywhere I-CAR classes are held. Watch for it.

For comments or suggestions on the Advantage Online, please contact I-CAR Senior Instructional Designer Bob Jansen at [bob.jansen@i-car.com](mailto:bob.jansen@i-car.com).

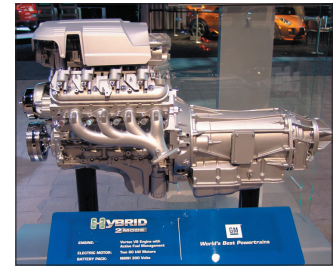


Figure 2– The GM two-mode hybrid system has two electric motors/generators incorporated into the transmission.



Figure 3– The Saturn Vue Green Line Hybrid vehicles use a Belt Alternator/ Starter type start/stop hybrid system.