

*PROGRESSIVE*  
AUTOMOTIVE

**X**PRIZE

# Fuel, Fuel Tanks and Quick Disconnects

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## Competition Fuels Will Be Commonly Available Pump Fuels

*“Miles-per-gallon equivalent (MPGe) is a pump-to-wheels energy efficiency figure of merit measure that expresses fuel economy in terms of the energy content of a U.S. gallon of gasoline. Calculations are based on the energy equivalence of all fuel(s) consumed...”*

### Fuel selections locked in for competition:

- Gasoline
- E85
- CNG – Compressed Natural Gas
- B20 – BioDiesel
- No waivers or special fuel requests have been made

# Temporary Fuel Tank

## Removable Tanks Simplify Competition Objective

*“To facilitate testing, PIAXP vehicles must satisfy the following requirements: Liquid fuels must be contained in removable tanks (for accurate measurement of fuel usage) ...Vehicles using liquid fuels must continuously communicate an accurate instantaneous rate of fuel use to the Data Acquisition System (DAS) in real time...Vehicles using gaseous fuels must have accurate temperature and pressure readings of the fuel at the regulator of every storage tank transmitted continuously in real time to the DAS...”*

### Fuel Cell supplier identified:

- ATL – leader in racing fuel cell manufacturing; from NASCAR to Navy
  - Fuels knowledge
  - Able to provide quantities of off-the-shelf parts
  - Custom tank design available (at Team’s expense!)



## Removable Tanks Support Competition Objective

*Safe, fast and repeatable connectors used by OEMs and military operations for un-beatable reliability*



### Quick Connect supplier identified:

- Jiffy-Tite Fuel Quick Connects
  - Fuels understanding, tech support
  - Able to provide quantities off the shelf parts that mate to ATL fuel cells
  - At APEX 2009

## Best Practices, DFM and DFMEA Mind Set

Considerations for SOP and far beyond:

- Chassis to powertrain variation and vibration
- Hot fuel handling testing
- For certification – evaporative and re-fueling testing
- GM failed exhaust test – Death Valley Grade simulation
- DAS considerations for competition
- Crashworthiness

## Chassis to Powertrain Vibration and Variation

OEMs build fuel lines for manufacturability and durability:

- Consider variation in dimensions of parts and brackets
- Consider movement of the powertrain
- The engine is a major source of vibration; hard lines fatigue
- How will these parts assemble and what is the sequence of build?
- When an impact occurs, what will stop fuel flow if there is a break in the fuel system integrity?

## Hot Fuel Testing

Testing the fuel system in less than ideal conditions:

- Fuels vary greatly from suppliers and seasons
- Fuel tank slosh can impact drivability and evaporative performance
- Ambient temperatures and barometric pressure can have substantial drivability and emissions probabilities
- It is not just hot weather that hurts

## Certification Evaporative Emissions and Re-Fueling

Not glamorous but still a requirement:

- Evaporative emissions not for Prototype – but need space for system
- Fueling at rates of 10 gallon per minute are required for regulations, for manufacturing higher can be needed
- On-board Re-fueling Vapor Recovery (ORVR)
- Motorcycles are CURRENTLY exempt from ORVR
- EVAP system leak diagnosis requires passive testing and system legacy information; leak-down testing calibration

## GM Failed Exhaust Testing

Releasing a design for production implies liability:

- Testing with vehicles in their normal operating state is not enough to ensure safe operation
- Some tests may seem like over-engineering
- The customer will not always do maintenance
- Being an engineer does not qualify someone to fix problems, but properly engineered designs reduce the number of problems that you have to fix
- A proper and complete DFMEA should be performed on each critical system of your vehicle

## Summary

You are the OEM:

- The customer will completely overlook the fuel system if it is done right
- Consider movement of the powertrain
- Consider effects of temperature and time