

HICEV AMERICA: HYDROGEN INTERNAL COMBUSTION ENGINE VEHICLE (HICEV) TECHNICAL SPECIFICATIONS

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MINIMUM VEHICLE REQUIREMENTS

The HICEV America Program is sponsored by the U.S. Department of Energy Office of Transportation Technology to provide for independent assessment of hydrogen fueled, internal combustion engine powered vehicles (HICEVs) in either hybrid or direct configurations. Vehicles tested under this program are evaluated against specific qualitative and quantitative metrics. The results provide potential users a method for comparing various HICEVs against consistent standards and against each other. The U.S. Department of Energy recognizes the HICEV America program as requisite for funding of programs involving HICEVs.

For a vehicle to be considered qualified for testing under the HICEV America Program, it must meet the minimum criteria defined by “shall” terminology utilized in the Specification. For clarity, the use of the word “Shall” defines minimum requirements, whereas the use of the word “Should” defines design and performance objectives. Vehicles that do not or cannot meet all of the “Shall” requirements will be considered Prototypes, and will not be considered as having successfully completed the HICEV America Program. The following requirements have been extracted from the body of the Vehicle Specification for convenience and clarity. In these requirements and in the Vehicle Specification, the term “Supplier” refers to the vehicle manufacturer or converter in the case of a conversion vehicle. Any vehicle must meet all of the following requirements before it can receive consideration under the HICEV America Program. Vehicles to be tested to these Specifications shall be road vehicles that draw propulsion energy from the combustion of pure hydrogen fuel in an internal combustion engine.

- (1) Vehicles shall comply with Federal Motor Vehicle Safety Standards applicable on the date of manufacture and such compliance shall be certified by the manufacturer in accordance with 49 CFR 567.

Suppliers shall provide a completed copy of Appendix A and Appendix B with their proposal, providing vehicle specifications and the method of compliance with each required section of 49 CFR 571. If certification includes exemption, the exemption number issued by the National Highway Transportation Safety Administration (NHTSA), the date of its publication in the Federal Register and the page number(s) of the Federal Register acknowledging issuance of the exemption shall be provided along with Appendix B.

Exemptions for any reason other than non-applicability shall not be allowed.

- (2) Suppliers shall provide Material Safety Data Sheets (MSDS) for all unique hazardous materials provided with the vehicle.
- (3) Compressed gas storage tanks shall comply with the requirements of 49CFR571.304 and ANSI/NGV2-2000.
- (4) Suppliers shall provide recycling plans for vehicle hazardous materials including how the plan has been implemented.
- (5) Vehicles shall have a minimum payload capability of at least 400 lbs. Payload is to include the driver, any passengers and any items not considered a permanent component of the vehicle whose weight is carried completely by the vehicle.

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- (6) For conversions of vehicles not manufactured by the HICEV Supplier, OEM gross vehicle weight rating (GVWR) shall not be increased.
For conversion vehicles, Suppliers shall specify the OEM's gross vehicle weight rating (GVWR).
- (7) For conversions of vehicles not manufactured by the HICEV Supplier, OEM Gross Vehicle Axle Weight Ratings (GAWR) shall not be increased. Suppliers shall provide axle weights for the vehicle as delivered, and at full rated payload.
- (8) A speedometer and an odometer shall be provided.
- (9) Tires shall be subject to the following requirements:
 - Tires provided with the vehicle shall be the standard tire offered by the HICE Supplier for the vehicle being proposed.
 - Tires shall correspond to the requirements of the placard installed in accordance with 49 CFR 571.109, 110, 119 and 120, as applicable.
 - Suppliers shall specify manufacturer, model and size of the standard tire.
 - Tires sizes and inflation pressures shall be in accordance with the requirements of the placard.
 - At no time shall the tire's inflation pressure exceed the maximum pressure imprinted upon that tire's sidewall.
 - The tire shall be operable across the entire operation/load range of that vehicle.
 - Replacement tires shall be commercially available to the end user in sufficient quantities to support the purchaser's needs.
 - If the vehicle may be equipped with more than one standard tire, the aforementioned information shall be provided for each type/manufacturer of each standard tire.
- (10) Seating capacity shall be a minimum of 1 driver and 1 passenger. Suppliers shall specify seating capacity (available seat belt positions) for their vehicle. For conversion vehicles, if the seating capacity is changed from that specified by the OEM on their FMVSS placard, the seat(s) being added or abandoned shall be modified as required by 49 CFR 571.207, et al, and a new FMVSS placard installed as required by 49 CFR 567, 568 or 571, as applicable.
- (11) For conversion vehicles, the OEM passenger space shall not be intruded upon by the Hydrogen Fuel Storage System (HFSS) or other conversion components.
- (12) The vehicle shall have a parking mechanism as per 49CFR571.102.
- (13) The engine shall utilize hydrogen fuel injection with the injectors located to inject fuel at either the throttle body, intake port or directly into the cylinder.
- (14) For conversions of vehicles not originally manufactured by the HICE vehicle Supplier, OEM engine modifications shall not require body modifications, which either intrude upon interior passenger space, reduce over hood visibility or impact vehicle crashworthiness.

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- (15) Vehicles shall comply with the requirements of 49 CFR 571.105.S5.2.1, or alternatively, 49 CFR 571.105.S5.2.2 for parking mechanisms.
- (16) Vehicles shall be capable of completing the HICEV America Rough Road Test (ETA-HITP-005) including (1) driving through standing water without damage, and (2) standing for extended periods in extreme temperatures without damage to or failure of the vehicle or its systems. Vehicles should be capable of completing the HEV America Rough Road Test (ETA-HITP-005) without becoming inoperable. Vehicle shall be capable of completing all HICEV America tests without repairs exceeding a cumulative total of 72 hours.
- (17) Fuel shall be stored onboard the vehicle in gaseous form.
- (18) Fuel storage tanks shall be installed as per the requirements of section 5.3 of NFPA 52-2002, Section 5.3.
- (19) Connection to the fuel storage tank shall utilize the fuel storage tank manufacturer's specified fittings.
- (20) Each fuel cylinder or assembly shall be protected by a pressure relief device(s) complying with ANSI PRD1-1998 (with 1999 addendum) - *Basic Requirements for Pressure Relief Devices for Natural Gas Vehicle Fuel Containers* and/or CGA-S-1.1, *Pressure Relief Device Standards—Part 1—Cylinders for Compressed Gases, 2003 edition*. Such pressure relief device shall be either temperature activated or pressure activated.
- (21) The pressure relieving device(s) shall be rated for hydrogen use by its manufacturer and acceptable for use by the cylinder manufacturer.
- (22) The pressure relief device shall be directly connected to the fuel cylinder or assembly or integral with the body of the isolation valve joined to the fuel cylinder or assembly.
- (23) A valve shall not be installed between the pressure relief device and the fuel cylinder.
- (24) The pressure relief device(s) vent shall be designed such that the vent system can withstand the pressures that result from venting and such that no gas will accumulate within or under any vehicle structure.
- (25) Fuel storage tank piping shall be rigid stainless steel and shall comply with the requirements of ASTM A269-2001 *Standard Specification for Seamless and Welded Austenitic Steel Tubing for General Service* or, A213/A213M *Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes*.
- (26) Fuel storage tank piping shall be installed as per the requirements of Section 5.5 of NFPA 52-2002.
- (27) Fuel piping shall be secured to the vehicle at least every 24 inches.
- (28) Flexible fuel piping shall only be used to connect two sections of fuel or vent pipe where relative motion between the two can reasonably be expected (e.g., between frame and engine). Any one section of flexible piping shall be limited to 16" in length.

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- (29) Flexible piping or hose shall only be installed downstream of the first pressure regulator.
- (30) Flexible piping shall be certified by its manufacturer for use with hydrogen. Such certification shall be provided with the vehicle submittal.
- (31) Each fuel storage tank shall be provided with an isolation valve mounted either inside the tank or affixed to the tank manufacturer's outlet.
- (32) The isolation valve shall either be a manually operated or normally closed, remotely actuated valve and shall be connected directly to the fuel cylinder so that it shuts off the supply of gas when closed. Connection to the fuel storage tank shall utilize the fuel storage tank manufacturer's specified fittings.
- (33) The fuel system shall be equipped with a manual or automatic shutoff valve. The shutoff valve shall isolate the fuel storage system from the remainder of the fuel system including the Fueling Connection Device.
- (34) Manual shutoff valves shall require no more than 90° of handle rotation to close the valve.
- (35) The shutoff valve shall be securely mounted to the vehicle and shall not be supported in any way by the fuel piping.
- (36) The location of the shutoff valve shall be clearly labeled and shall be accessible from outside the vehicle.
- (37) Fuel pressure regulator(s) shall be located as close as practical to the shutoff valve.
- (38) A pressure relief valve shall be fitted on the regulated side of the first stage of the regulator with a relief pressure setting designed to protect all components downstream of the regulator.
- (39) The pressure relief valve vent shall be designed to withstand the pressures developed during venting and such that vented gasses cannot accumulate within or under any vehicle structure.
- (40) An automatic valve shall be installed in the fueling system that prevents the flow of hydrogen gas to the engine when the engine is not running, even if the ignition switch is in the "ON", "RUN", or "ACC" position.
- (41) The Fueling Connection Device shall be mechanically keyed for the nominal storage pressure using the SAE 2600-2002: *Compressed Hydrogen Vehicle Fueling Connection Devices* standard to avoid connection to a higher than allowable pressure dispenser.
- (42) The Fueling Connection Device shall be matched to the nominal design pressure of the fuel storage cylinder(s).
- (43) The Fueling Connection Device shall include dual check valves to prevent fuel leakage from the inlet.
- (44) The Fueling Connection Device shall be securely mounted to the vehicle and shall not be supported in any way by the inlet piping.

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- (45) Fueling Connection Device piping shall be rigid stainless steel and shall comply with the requirements of ASTM A269-2001 *Standard Specification for Seamless and Welded Austenitic Steel Tubing for General Service* or, A213/A213M *Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes*.
- (46) Fueling Connection Device piping shall be secured to the body and/or frame at least every 24 inches.
- (47) Piping connection to the Fueling Connection Device shall utilize the manufacturer's recommended fittings.
- (48) The fuel system shall be equipped with a fuel quantity indicating device. This device shall indicate either actual pressure (gauge pressure in pounds-per-square-inch) within the storage tank(s) or an indication of Full to Empty based on, at a minimum, actual pressure within the storage tank(s).
- (49) A fuel gauge installed in the passenger compartment shall be electrically operated with the pressurized sending unit installed in the fuel system outside of any passenger spaces.
- (50) The Supplier shall provide recommended fuel system maintenance requirements, including requirements, if any, for periodic fuel system integrity checks.
- (51) Suppliers shall specify all optional equipment required to meet the requirements of this Vehicle Specification.

The installation of options shall not relieve Suppliers of meeting other "shall" requirements.
- (52) Non-proprietary manuals for parts, service, operation and maintenance, interconnection wiring diagrams and schematics shall accompany all vehicles submitted for testing.

The following sections constitute the Technical Requirements of the Vehicle Specification. Information has been categorized according to component and/or function. This Technical Specification establishes the minimum requirements for Production level HICE vehicles, as well as identifying design and performance objectives.

No inference should be drawn by Suppliers or any other person that the measures listed in this specification are sufficient to make the vehicle safe. Each Supplier shall acknowledge in writing that 1) it is solely responsible for determining whether each vehicle offered for sale is safe, and 2) it is not relying on Electric Transportation Applications or the U.S. Government as having, by this specification and its requirements, established minimally sufficient safety standards. This written statement shall be provided with the Supplier's submittal.

1. REGULATORY REQUIREMENTS

1.1 FMVSS CERTIFICATION

Vehicles shall comply with Federal Motor Vehicle Safety Standards applicable on the date of manufacture and such compliance shall be certified by the vehicle Supplier in accordance with 49 CFR 567. Suppliers shall provide a completed copy of Appendix A and Appendix B with their proposal, providing vehicle specifications and the method of compliance with each required section of 49 CFR 571. If certification includes exemption, the exemption number issued by the National Highway Transportation Safety Administration (NHTSA), the date of its publication in the Federal Register and the page number(s) of the Federal Register acknowledging issuance of the exemption shall be provided along with Appendix B. Exemptions for any reason other than non-applicability shall not be allowed.

1.2 VEHICLE EMISSIONS CERTIFICATION

Vehicles should be certifiable under current California Air Resources Board (CARB) or Environmental Protection Agency (EPA) regulations as a SULEV vehicle.

1.3 SAFETY FEATURES

Suppliers should describe safety measures and safety-related design features included in their vehicle design and provide an explanation of the purpose and anticipated effect on vehicle reliability and performance of any such safety measure or design feature.

1.4 MATERIAL SAFETY DATA SHEETS

Suppliers shall provide Material Safety Data Sheets (MSDS) for all unique hazardous materials provided with the vehicle.

1.5 FUEL SYSTEM

Compressed gas storage tanks shall comply with the requirements of 49CFR571.304 and ANSI/NGV2-2000.

1.6 HAZARDOUS MATERIALS RECYCLING PLANS

Suppliers shall provide recycling plans for vehicle hazardous materials including how the plan has been implemented. This plan should also identify post-purchase costs associated with recycling that will be passed on to the vehicle purchaser.

2. CHASSIS

2.1 RATED PAYLOAD

Vehicles shall have a minimum payload of at least 400 pounds. Payload is to include the driver, any passengers and any items not considered a permanent component of the vehicle whose weight is carried completely by the vehicle.

2.2 CURB WEIGHT AND GROSS VEHICLE WEIGHT RATING (GVWR)

For conversions of vehicles not manufactured by the HICEV Supplier, OEM gross vehicle weight rating (GVWR) shall not be increased. Suppliers should provide the curb weight and rated payloads of their vehicles. For conversion vehicles, Suppliers shall specify the OEM's gross vehicle weight rating (GVWR).

2.3 VEHICLE WEIGHT DISTRIBUTION

For conversions of vehicles not manufactured by the HICEV Supplier, OEM Gross Vehicle Axle Weight Ratings (GAWR) shall not be increased. Suppliers shall provide axle weights for the vehicle as delivered, and at full rated payload.

2.4 SPEEDOMETER AND ODOMETER

A speedometer and an odometer shall be provided and should have an accuracy of at least $\pm 5\%$ at speeds above 20 mph.

2.5 BRAKING AND STEERING PERFORMANCE

For conversions of vehicles not manufactured by the HICEV Supplier, braking and steering efforts should be similar to OEM models of comparable size and weight.

2.6 TIRES

Tires shall be subject to the following requirements:

- Tires provided with the test vehicle shall be the standard tire offered by the HICEV Supplier for the vehicle being proposed.
- Tires shall correspond to the requirements of the placard installed in accordance with 49 CFR 571.109, 110, 119 and 120, as applicable.
- Suppliers shall specify manufacturer, model and size of the standard tire.
- Tires sizes and inflation pressures shall be in accordance with the requirements of the placard.
- At no time shall the tire's inflation pressure exceed the maximum pressure imprinted upon that tire's sidewall.
- The tire shall be operable across the entire operation/load range of that vehicle.
- Replacement tires shall be commercially available to the end user in sufficient quantities to support the purchaser's needs.
- If the vehicle may be equipped with more than one standard tire, this information shall be provided for each type/manufacturer of each standard tire.

2.7 GROUND CLEARANCE

Vehicles should have a ground clearance of at least five (5) inches to all sprung portions of the vehicle, with the vehicle loaded with rated payload (e.g. to GVWR).

3. VEHICLE CHARACTERISTICS

3.1 SEATING CAPACITY

Seating capacity shall be a minimum of 1 driver and 1 passenger. Suppliers shall specify seating capacity (available seat belt positions) for their vehicle. For conversion vehicles, if the vehicle's seating capacity is changed from that specified by the OEM on their FMVSS placard, the seat(s) being added or abandoned shall be modified as required by 49 CFR 571.207, et al, and a new FMVSS placard installed as required by 49 CFR 567, 568 or 571, as applicable.

3.2 PASSENGER AND CARGO SPACE

For conversion vehicles, the OEM passenger space shall not be intruded upon by the Hydrogen Fuel Storage System (HFSS) or other conversion components. Suppliers should specify interior passenger and cargo dimensions and volumes.

3.3 ELECTROMAGNETIC SUSCEPTIBILITY

Vehicles should comply with the relevant sections of SAE J551-1996 for electromagnetic radiated fields. Vehicles should not be susceptible to externally generated electromagnetic radiation from an on-board transmitter (i.e., interaction will not preclude operation of any systems required for proper operation of the vehicle).

Vehicles should comply with the relevant sections of SAE J551-1996 for susceptibility to electromagnetic fields. Vehicles should not be susceptible to externally generated electromagnetic radiation from an on-board radio transmitter (i.e., interaction will not preclude operation of any system(s) required for proper operation of the vehicle).

4. DRIVE SYSTEM

4.1 TRANSMISSION

The vehicle should utilize a single speed, multi-speed automatic, or a continuously variable transmission (CVT), and shall have a parking mechanism as per 49CFR571.102.

4.2 OVERHEATING

The vehicle drive-train system should be capable of continuous operation on sustained grades of at least 6% at a speed of at least 45 mph without overheating or loss of component life over the range of ambient temperatures specified in Section 5.5.

4.3 ENGINE

The engine shall utilize hydrogen fuel injection with the injectors located to inject fuel at either the throttle body, intake port or directly into the cylinder.

For conversions of vehicles not originally manufactured by the HICE vehicle Supplier, OEM engine modifications shall not require body modifications, which either intrude upon interior passenger space, reduce over hood visibility or impact vehicle crashworthiness.

4.4 DRIVETRAIN

Drivetrain components should not produce or develop unusual vibrations over the entire design speed range of the vehicle.

4.5 PARKING MECHANISM

Vehicles shall comply with the requirements of 49 CFR 571.105.S5.2.1, or alternatively, 49 CFR 571.105.S5.2.2 for parking mechanisms.

5. VEHICLE PERFORMANCE

5.1 ACCELERATION

The vehicle should have a 0-50 mph acceleration time of 13.5 seconds or less with the vehicle loaded to its design curb-weight plus 332 pounds

5.2 MINIMUM TOP SPEED

The vehicle should have a minimum top speed of 70 MPH with the vehicle loaded to its design curb-weight plus 332 pounds

5.3 HIGH SPEED GRADEABILITY

Vehicles should achieve a minimum sustainable speed of 55 mph on a 3% grade, and 45 mph on a 6% grade, with the vehicle loaded to its design curb-weight plus 332 pounds

5.4 LOW SPEED GRADEABILITY

Vehicles should be capable of starting and ascending a 25% grade with the vehicle loaded to its design curb-weight plus 332 pounds

5.5 DURABILITY

Vehicles shall be capable of completing the HICEV America Rough Road Test (ETA-HITP-005) including (1) driving through standing water without damage, and (2) standing for extended periods in extreme temperatures without damage to or failure of the vehicle or its systems. Vehicles should be capable of completing the HEV America Rough Road Test (ETA-HITP-005) without becoming inoperable. Vehicle shall be capable of completing all HICEV America tests without repairs exceeding a cumulative total of 72 hours.

Vehicles should be capable of standing for extended periods in extreme temperatures without damage to or failure of the vehicle or its systems. This includes ambient air temperatures of -20°F to +120°F, paved surface temperatures of 150°F, and occupant compartment temperatures of 170°F.

5.6 FUEL ECONOMY

Vehicles should be accompanied with fuel economy data from Supplier's testing. Vehicles will be tested for fuel economy while operating on a combined drive cycle test consisting of two (2) Urban Dynamometer Driving Schedules (UDDS) followed by two (2) Highway Fuel Economy Driving Schedules.

5.7 RANGE

Vehicle range should be at least 100 miles when operating on a combined drive cycle test consisting of two (2) Urban Dynamometer Driving Schedules (UDDS) followed by two (2) Highway Fuel Economy Driving Schedules.

6. HYDROGEN ENERGY STORAGE SYSTEM

6.1 FUEL STORAGE

Fuel shall be stored onboard the vehicle in gaseous form.

6.2 FUEL STORAGE TANK AND PIPING

Fuel storage tanks and shall be installed as per the requirements of NFPA 52-2002, Section 5.3. Connection to the fuel storage tank shall utilize the fuel storage tank manufacturer's specified fittings.

Each fuel cylinder or assembly shall be protected by a pressure relief device(s) complying with ANSI PRD1-1998 (with 1999 addendum) - *Basic Requirements for Pressure Relief Devices for Natural Gas Vehicle Fuel Containers* and/or CGA-S-1.1, *Pressure Relief Device Standards—Part 1—Cylinders for Compressed Gases, 2003 edition*. Such pressure relief device shall be either temperature activated or pressure activated. The pressure relieving device(s) shall be rated for hydrogen use by its manufacturer and acceptable for use by the cylinder manufacturer. The pressure relief device shall be directly connected to the fuel cylinder or assembly or integral with the body of the isolation valve joined to the fuel cylinder or assembly. A valve shall not be installed between the pressure relief device and the fuel cylinder. The pressure relief device(s) vent shall be designed such that the vent system can withstand the pressures that result from venting and such that no gas will accumulate within or under any vehicle structure.

Fuel storage tank piping shall be rigid stainless steel and shall comply with the requirements of ASTM A269-2001 *Standard Specification for Seamless and Welded Austenitic Steel Tubing for General Service* or, A213/A213M *Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes*. Fuel storage tank piping shall be installed as per the requirements of Section 5.5 of NFPA 52-2002. Fuel storage tank piping shall be secured to the vehicle at least every 24 inches.

Flexible fuel piping shall only be used to connect two sections of fuel or vent pipe where relative motion between the two can reasonably be expected (e.g., between frame and engine). Any one section of flexible piping shall be limited to 16" in length. Flexible piping or hose shall only be installed downstream of the first pressure regulator. Flexible piping shall be certified by its manufacturer for use with hydrogen. Such certification shall be provided with the vehicle submittal.

Each fuel storage tank shall be provided with an isolation valve mounted either inside the tank or affixed to the tank manufacturer's outlet. The isolation valve shall either be manually operated or a normally closed, remotely actuated valve and shall be connected directly to the fuel cylinder so that it shuts off the supply of gas when closed. Connection to the fuel storage tank shall utilize the fuel storage tank manufacturer's specified fittings.

The fuel system shall be equipped with a manual or automatic shutoff valve. The shutoff valve shall isolate the fuel storage system from the remainder of the fuel system including the Fueling Connection Device. Manual shutoff valves shall require no more than 90° of handle

rotation to close the valve. The shutoff valve shall be securely mounted to the vehicle and shall not be supported in any way by the fuel piping. The location of the shutoff valve shall be clearly labeled and shall be accessible from outside the vehicle. Fuel piping between the isolation valve(s), the shutoff valve and the pressure regulator inlet should not contain fittings of any type.

Fuel pressure regulator(s) shall be located as close as practical to the shutoff valve. A pressure relief valve shall be fitted on the regulated side of the first stage of the regulator with a relief pressure setting designed to protect all components downstream of the regulator. The pressure relief valve vent shall be designed to withstand the pressures developed during venting and such that vented gasses cannot accumulate within or under any vehicle structure.

An automatic valve shall be installed in the fueling system that prevents the flow of hydrogen gas to the engine when the engine is not running, even if the ignition switch is in the "ON", "RUN", or "ACC" position.

All fuel storage and distribution components and fittings should be listed or approved and certified by their manufacturer for use with hydrogen. Evidence of such listings or approvals and certification shall be provided with the vehicle submittal.

6.3 FUELING CONNECTION DEVICE

The Fueling Connection Device shall be mechanically keyed for the nominal storage pressure in accordance with SAE 2600-2002: *Compressed Hydrogen Vehicle Fueling Connection Devices*, to avoid connection to a higher than allowable pressure dispenser. The Fueling Connection Device shall be matched to the nominal design pressure of the fuel storage cylinder(s). The Fueling Connection Device shall include dual check valves to prevent fuel leakage from the inlet. The Fueling Connection Device shall be securely mounted to the vehicle and shall not be supported in any way by the inlet piping.

Fueling Connection Device piping shall be rigid stainless steel and shall comply with the requirements of ASTM A269-2001 *Standard Specification for Seamless and Welded Austenitic Steel Tubing for General Service* or, A213/A213M *Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes*. Fueling Connection Device piping shall be secured to the body or frame at least every 24 inches. Piping between the Fueling Connection Device and its connection with the fuel piping should not contain fittings of any type. Piping connection to the Fueling Connection Device shall utilize the manufacturer's recommended fittings.

6.4 FUEL GAUGE

The fuel system shall be equipped with a fuel quantity indicating device. This device shall indicate either actual pressure (gauge pressure in pounds-per-square-inch) within the storage tank(s) or and indication of Full to Empty based on, at a minimum, actual pressure within the storage tank(s). A fuel gauge installed in the passenger compartment shall be electrically

operated with the sending unit installed in the fuel system outside of any passenger spaces. The fuel gauge should be accurate to $\pm 10\%$ of full scale.

6.5 FUEL SYSTEM MAINTENANCE

The Supplier shall provide recommended fuel system maintenance requirements, including requirements, if any, for periodic fuel system integrity checks.

7. ADDITIONAL VEHICLE SYSTEMS

Suppliers shall specify all optional equipment required to meet the requirements of this Vehicle Specification. Suppliers should describe the following options, if available. The installation of options shall not relieve Suppliers of meeting other “shall” requirements. Suppliers should specify the impact on fuel economy and payload for each option.

7.1 AIR CONDITIONING SYSTEM

Suppliers should describe the design of the air conditioning system and verify that it uses refrigerant containing no chloroflourocarbons (CFCs).

8.0 DOCUMENTATION

8.1 SERVICE MANUALS

Non-proprietary manuals for parts, service, operation and maintenance, interconnection wiring diagrams and schematics shall accompany vehicles. Manuals should include details on the design and operation of vehicle systems, including the fuel system, as well as a list of additional or special maintenance tools required.

8.2 TRAINING PROGRAM

Suppliers should offer a training program for the purchaser's maintenance personnel covering vehicle safety and proper operation and maintenance of vehicles.

APPENDIX A - VEHICLE DATA

PERFORMANCE

Time required to accelerate from 0-60 on a level grade(s) _____
Time required to accelerate from 0-55 on a 3% grade(s) _____
Time required to accelerate from 0-45 on a 6% grade(s) _____
Maximum speed attainable on a level grade (mph) _____
Maximum grade attainable from a standing start at GVWR (%) _____
Range over the SAE J1634 combined UDS-HWFET cycle (miles) _____

FUEL STORAGE TANK

Manufacturer _____
Model _____
Type _____
Description _____
Liquid Volume (liters) _____
Nominal and MAWP (psi) _____ psi (nominal) _____ psi (MAWP)

ENGINE

Model _____
Configuration _____
Displacement (liters) _____
Number of Cylinders _____
Maximum Power (hp@rpm) _____
Maximum Torque (lb-ft@rpm) _____
Maximum Speed (rpm) _____

TRANSMISSION CHARACTERISTICS

Manufacturer _____
Type _____
Model _____
Description _____
Gear Ratio(s) _____

APPENDIX A (cont)

CHASSIS CHARACTERISTICS (Pre-conversion, if applicable)

Make, Year and Model _____
Gross vehicle weight rating (kg) _____
Gross axle weight rating (kg) _____ front _____ rear
Curb weight (kg) _____
Drive Wheels (F/R) _____
Weight distribution _____ % front _____ % rear
Payload capacity (kg) _____
Ground clearance from lowest point on chassis at GVWR (cm) _____
Passenger area dimension _____
Passenger area volume _____
Cargo area dimensions _____
Cargo area volume _____
Wheelbase _____ inches
Track _____ inches front _____ inches rear
Body height _____ inches
Body width _____ inches

CHASSIS CHARACTERISTICS (Post-conversion or OEM)

Curb weight (kg) _____
Drive Wheels (F/R) _____
Weight distribution _____ % front _____ % rear
Payload capacity (kg) _____
Ground clearance from lowest point on chassis at GVWR (cm) _____
Cargo area dimensions _____
Cargo area volume _____
Wheelbase _____ inches
Track _____ inches front _____ inches rear
Body height _____ inches
Body width _____ inches

BRAKES

Type front _____
Type rear _____
Power source, if used _____

APPENDIX A (cont.)

TIRES

Manufacturer _____
Model _____
Description _____
Size and profile _____
Pressure (psi) _____ front _____ rear
Weight capacity (lbs) _____

SUSPENSION

Type front _____
Type rear _____
Modifications made during conversion, if any _____

STEERING

Type _____
Description _____
Manufacturer _____
Power source, if used _____

APPENDIX A (cont.)

REQUIRED SUBMITTALS

The following submittals are required from the Supplier prior to vehicle delivery.

- Each Supplier shall acknowledge in writing that 1) it is solely responsible for determining whether each vehicle offered for sale is safe, and 2) it is not relying on Electric Transportation Applications or the U.S. Government as having, by this specification and its requirements, established minimally sufficient safety standards. This written statement shall be provided with the Supplier's submittal.
- Suppliers shall provide a completed copy of Appendix A and Appendix B with their proposal, providing vehicle specifications and the method of compliance with each required section of 49 CFR 571. If certification includes exemption, the exemption number issued by the National Highway Transportation Safety Administration (NHTSA), the date of its publication in the Federal Register and the page number(s) of the Federal Register acknowledging issuance of the exemption shall be provided along with Appendix B.
- Suppliers should describe safety measures and safety-related design features included in their vehicle design and provide an explanation of the purpose and anticipated effect on vehicle reliability and performance of any such safety measure or design feature.
- Suppliers shall provide Material Safety Data Sheets (MSDS) for all unique hazardous materials provided with the vehicle.
- Suppliers shall provide recycling plans for vehicle hazardous materials including how the plan has been implemented. This plan should also identify post-purchase costs associated with recycling that will be passed on to the vehicle purchaser.
- Suppliers shall specify seating capacity (available seat belt positions) for their vehicle.
- Suppliers should specify interior passenger and cargo dimensions and volumes.
- Compressed gas storage tanks shall comply with the requirements of 49CFR571.304 and NGV2-2000.
- Fuel stored onboard the vehicle shall be stored in gaseous form. Evidence of such compliance shall be provided with the vehicle submittal.
- All fuel storage and distribution components and fittings should be listed or approved and certified by their manufacturer for use with hydrogen. Evidence of such listings or approvals and certification shall be provided with the vehicle submittal.
- Fuel storage tanks shall be installed in accordance with the requirements of NFPA 52-2002, Section 5.3. Evidence of such compliance shall be provided with the vehicle submittal.
- All piping connections to components shall utilize the manufacturer's specified fittings. Evidence of such compliance shall be provided with the vehicle submittal.
- Flexible piping shall be certified by its manufacturer for use with hydrogen. Such certification shall be provided with the vehicle submittal.

HICEV America Vehicle Specification

- All piping systems shall comply with the requirements of ASTM A269-2001 or A213/A213A. Evidence of such listings or approvals and certification shall be provided with the vehicle submittal.
- All piping systems shall be installed per NFPA 52-2002, Section 5.5. Evidence of such compliance shall be provided with the vehicle submittal.
- Suppliers shall confirm that all piping systems—both fuel supply and venting—are designed to adequately withstand expected operating pressures
- All pressure relief devices shall be selected and designed to appropriately protect the components and system to which they are connected. Evidence of such compliance shall be provided with the vehicle submittal.
- Fueling connection devices shall be mechanically keyed for the nominal storage pressure using the SAE 2600-2002: *Compressed Hydrogen Vehicle Fueling Connection Devices* standard. Fueling connection devices shall match the nominal design pressure of the fuel storage tanks and shall include dual check valves. Evidence of such listings or approvals and certification shall be provided with the vehicle submittal.
- The supplier shall provide recommended fuel system maintenance requirements, including requirements, if any for periodic fuel system integrity checks.
- Suppliers shall specify all optional equipment required to meet the requirements of this Vehicle Specification.
- Suppliers should describe the design of the air conditioning system and verify that it uses no chloroflourocarbons (CFCs).
- Non-proprietary manuals for parts, service, operation and maintenance, interconnection wiring diagrams and schematics shall accompany vehicles. Manuals should include details on the design and operation of vehicle systems, including the fuel system as well as a list of additional or special maintenance tools required.
- Suppliers should offer a training program for the purchaser's maintenance personnel covering vehicle safety and proper operation and maintenance of vehicles.

APPENDIX B - FMVSS Certification Methodology

	OEM Certified	Analysis Only	Test Only	Test & Analysis	Not Required	Not Certified
49 CFR 571.100 SERIES						
101 - Controls and Displays	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
102 - Transmission Shift Lever Sequence, Starter Interlock & Transmission Braking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
103 - Windshield Defrosting and Defogging Systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
104 - Windshield Wiping and Washing Systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
105 - Hydraulic Brake Systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
106 - Brake Hoses	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
108 - Lamps, Reflective Devices, and Associated Equipment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
109 - New Pneumatic Tires	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
110 - Tire Selection and Rims	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
111 - Rearview Mirrors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
113 - Hood Latch System	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
114 - Theft Protection	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
116 - Motor Vehicle Brake Fluids	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
118 - Power Operated Window, Partition, and Roof Panel Systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
119 - New Pneumatic Tires for Vehicles Other Than Passenger Cars	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
120 - Tire Selection and Rims for Motor Vehicles Other Than Passenger Cars	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
121 - Air Brake Systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
124 - Accelerator Control Systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
125 - Warning Devices	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
129 - New Non-Pneumatic Tires for Passenger Cars	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
135 - Light Vehicle Brake Systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

APPENDIX B (continued)

	OEM Certified	Analysis Only	Test Only	Test & Analysis	Not Required	Not Certified
49 CFR 571.200 SERIES						
201 - Occupant Protection in Interior Impact	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
202 - Head Restraints	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
203 - Impact Protection for the Driver from the Steering Control System	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
204 - Steering Control Rearward Displacement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
205 - Glazing Materials	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
206 - Door Locks and Door Retention Components	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
207 - Seating Systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
208 - Occupant Crash Protection	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
209 - Seat Belt Assemblies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
210 - Seat Belt Assembly Anchorages	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
212 - Windshield Mounting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
213 - Child Restraint Systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
214 - Side Impact Protection	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
216 - Roof Crush Resistance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
219 - Windshield Zone Intrusion	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
223 - Rear Impact Guards	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
225 - Child Restraint Anchorage System	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
49 CFR 571.300 SERIES						
301 - Fuel System Integrity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
302 - Flammability of Interior Materials	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
303 - Fuel System Integrity of Compressed Natural Gas Vehicles	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
304 - Compressed Natural Gas Fuel Container Integrity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
49 CFR 581						
Bumper Standard Requirements - All Sections	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
49 CFR 565						
Vehicle Identification Number Requirements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>