

## **First Technical Deliverable**

### **Introduction:**

#### **Pre-Track-Event, “Technical Deliverable” Reports**

The requirement from all qualified PIAXP Teams for several pre-track-event reports is intended to increase the safety and reliability of PIAXP vehicles, and also to facilitate the development of competitive vehicles.

The three technical readiness reports will be designated as First Technical Deliverable, Second Technical Deliverable, and Third Technical Deliverable. The due date for each report is listed below.

<b>First Technical Deliverable -</b>	<b>Due December 15, 2009</b>
<b>Second Technical Deliverable -</b>	<b>Due January 30, 2010</b>
<b>Third Technical Deliverable -</b>	<b>Due March 30, 2010</b>

The Second and Third Technical Deliverable packages will be submitted to you roughly 45 days before the due dates listed above.

All Technical Deliverable reports will be submitted through a web-based template into which information, diagrams, and images are inserted and submitted electronically. (The template to fill in for First Technical Deliverable is on the following pages). The organizers will review these and may make suggestions or provide direction to Qualified Teams to address items that do not comply with the Technical Specifications.

For each successive Technical Deliverable, increasingly detailed information will be asked for by the organizers, and must be provided about each of the Teams' vehicles.

Qualified Teams that do not comply with Technical Deliverable progress report deadlines, or do not address items as directed by the organizers, may face disqualification from the Progressive Automotive X PRIZE.

Items to be addressed in the reports will include the following:

- High Voltage Energy Storage Systems / other ESS**
- Fuel System**
- Powertrain and Emissions**
- Body and Chassis**
- Current Performance, Measurements, & Specs**

More details about the Technical Deliverables will be discussed at the SEMA Summit.

## **Instructions for First Technical Deliverable Submission**

1. Fill in ALL information electronically in the designated spaces of the template.
2. Make sure Team information is filled in first!
3. A separate template must be completed for every vehicle entered into the competition by each team.
4. If a section does not apply to your vehicle, do not leave blank, insert “DNA”
5. The submission of all requested photos, charts, drawings, graphs, tables, manufacturer’s sheets, etc.:
  - a. Must all be in PDF format
  - b. Must all be included in one PDF format file
  - c. Each picture, etc. must be clearly identified or titled, with Team, Subject, and Tech Deliverable Section identifier (i.e. [TD1-1-19a](#)).
6. Completed Technical Deliverable package should be delivered electronically to Julie Zona and Bethann Buddenbaum, Team Development and Relations, on or before the deadline date, 5PM eastern.

# FIRST TECHNICAL DELIVERABLE – TD1

## Required Team Information

\_\_\_\_\_ Team Name \_\_\_\_\_ Vehicle Name  
\_\_\_\_\_ Vehicle # (TBD) \_\_\_\_\_ ESS Technical Contact  
\_\_\_\_\_ Phone \_\_\_\_\_ Email

### Please Note:

Teams are required to complete all information on this form for each vehicle entered. Teams must provide justification why any information is not available at the end of the Sections.

Teams will be required to update the data and submit a revised specification sheet at the same time the Second and Third Technical Deliverables are submitted.

To avoid any miscommunication and help reduce work during the revision, teams are asked to fill out the form using MS Word rather than hand writing. Teams can add additional lines where necessary and check boxes () can be changed by double clicking on them.

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## Section TD1-1

### Energy Storage and High Voltage System Specification (v2.9)

This Section is primarily designed for electrochemical batteries. If a vehicle has a different type of storage system, they are asked to contact PIAXP for additional directions.

**Please note, that teams must have their ESS ordered by the first technical deliverable on December 15, 2009 date (subject to change). No changes to the ESS will be allowed after this date.**

#### TD1-1-1 Energy Storage, General Information

Lithium       Nickel Metal-Hydride       Lead Acid       Other\_\_\_\_\_

Anode\_\_\_\_\_ Cathode\_\_\_\_\_ Electrolyte\_\_\_\_\_

#### TD1-1-2 Status of ESS (check all that have been completed)

Received       Purchased       Exact ESS selected       ESS not selected

\_\_\_\_\_

For each action not completed, please denote anticipated completion date on the line below

**TD1-1-3 ESS Manufacturer**

\_\_\_\_\_ Manufacturer \_\_\_\_\_ Model #

Manufacturer Contact Information (name, phone, address, and website)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**TD1-1-4 Cell Specifications**

\_\_\_\_\_ Nominal\_Cell Voltage \_\_\_\_\_ Cell Capacity  
(Ah @ C/3)  
\_\_\_\_\_ Cell Energy (kWh @ C/3) \_\_\_\_\_ Cell Weight (kg)  
\_\_\_\_\_ Critical Temperature \*(C) \_\_\_\_\_ Critical Cell  
Voltage\*

(\*Temperature and voltage where cell can automatically begin self-heating)

Provide a description of any safety requirements or devices on the cells, such as vents, shutdown separators, etc.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**TD1-1-5 Pack Specifications**

Status of Pack (check all that have been completed)

Complete  Building  Design Complete  Designing

For each action not completed, please denote anticipated completion date on the line below

\_\_\_\_\_ Pack Capacity (Ah @ C/3) \_\_\_\_\_ Pack Energy (kWh @ C/3)  
\_\_\_\_\_ # Packs \_\_\_\_\_ # Cells per String \_\_\_\_\_ # Strings per Pack  
\_\_\_\_\_ Nominal\_Pack Voltage \_\_\_\_\_ Max. continuous discharge current  
\_\_\_\_\_ Peak discharge current \_\_\_\_\_ Time for Peak discharge (s)  
\_\_\_\_\_ Max. Regenerative braking current \_\_\_\_\_ Max operating voltage  
\_\_\_\_\_ Max Voltage during charging \_\_\_\_\_ Max current during charging  
\_\_\_\_\_ Total Battery Weight (kg) \_\_\_\_\_ Total Battery System Weight (kg)  
(including BMS, enclosure, etc)



Please describe the design and operation of the thermal management system for your ESS. Include details on how your cooling system will maintain uniform target temperatures across the pack during the charging and discharging, including calculations on thermal load and cooling capabilities. Also provide information on the temperature monitoring system and actions that will be taken in case the event of a thermal runaway during both driving and charging. Provide a test plan on how the thermal management system will be tested under all possible simulated temperatures. Teams using advanced chemistries, such as lithium and nickel-metal hydride should be aware that the technical inspectors consider the thermal management of the pack a key safety concern and teams with inadequate systems will be disqualified from the competition.

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Please describe the operation and design of your BMS for your ESS. Include details such as parameters monitored, number and placement of sensors, and safety actions in case of a thermal or voltage excursion. Teams using advanced chemistries, such as lithium and nickel-metal hydride should be aware that the technical inspectors consider the BMS of the pack a key safety concern and teams with inadequate systems will be disqualified from the competition.

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### TD1-1-8 Charger

**Status of Charger** (check all that have been completed)

Received/Built       Purchased       Exact ESS selected       ESS not selected

\_\_\_\_\_

For each action not completed, please denote anticipated completion date on the line below the item

\_\_\_\_\_ Manufacturer      \_\_\_\_\_ Model #

Manufacturer Contact Information (name, phone, address, and website)

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Does the charger provide galvanic isolation between the ac input and vehicle:     Yes       No

Is the vehicle chassis connected to earth ground:       Yes       No

Location:       On-board Vehicle       Off-board Vehicle       Other \_\_\_\_\_

\_\_\_\_\_ Input Voltage Range      \_\_\_\_\_ Output Voltage Range

\_\_\_\_\_ Max. Input Current                      \_\_\_\_\_ Min. Required Current  
 \_\_\_\_\_ Nominal Charging Efficiency (Wall to Plug)  
 \_\_\_\_\_ UL/CSA Approved?                      \_\_\_\_\_ Meets FCC Class B, 15?

Please describe the operation and design of your charger for your ESS. Include key components used (transformer, solid state switches, etc.) Include details such as parameters monitored, method of determining 100% SOC, charging profile, weatherproofing, unattended operation, over-charging protection, isolation fault detection, and reverse polarity protection. Teams should be aware that the technical inspectors consider the charger of the pack a key safety concern and teams with inadequate systems will be disqualified from the competition.

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**High Voltage System** (for all electrical systems used to provide propulsion (regardless of voltage) or any systems greater than 50V)

**TD1-1-9 High Voltage Schematics**

Please provide a complete and detailed high voltage description of your high voltage system. You must also provide a schematic which must include the Ground Fault Isolation (GFI) monitor, Emergency Disconnect Switch (EDS), inertia disconnect switch, Manual Isolation Switch (MIS), traction battery fuses, all bulk capacitors, all capacitors from HV to vehicle chassis (“Y-Caps”), all resistors between HV positive and negative, all resistors from HV to vehicle chassis, all HV components (complete with manufacturer and part numbers of all components): including power switches (inverters and dc/dc converters), electrical motors, pumps, etc.

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**TD1-1-10 Status of Ground Fault Isolation (GFI) Monitor** (check all that have been completed)

Received/Built                       Purchased                       Exact GFI selected                       GFI not selected

\_\_\_\_\_   
 For each action not completed, please denote anticipated completion date on the line below

\_\_\_\_\_ Manufacturer \_\_\_\_\_ Model #

In the HV schematics, please be sure to provide details exactly how and where your GFI is connected between the HV bus and vehicle chassis. Additionally, include photos if possible.

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If not purchasing a GFI, please describe in detail how your GFI works and ensures < 1mA of leakage current detection.

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**TD1-1-11 Status of Emergency Disconnect Switch (EDS)** (check all that have been completed)

Received/Built       Purchased       Exact EDS selected       EDS not selected

For each action not completed, please denote anticipated completion date on the line below

\_\_\_\_\_ Manufacture \_\_\_\_\_ Model #

**TD1-1-11a** Please provide photos showing the EDS properly installed in the two locations as required in the technical specifications. Photos or diagrams must also be provided that show the contactor associated with the EDS is < 3 feet from the HV source. This is required so that when the EDS is engaged, there is no remaining HV exposed elsewhere on the vehicle.

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**TD1-1-12 Status of Inertia Switch** (check all that have been completed)

Received/Built       Purchased       Exact Switch selected       Switch not selected

For each action not completed, please denote anticipated completion date on the line below box

\_\_\_\_\_ Manufacture \_\_\_\_\_ Model #

**TD1-1-13 Status of Manual Isolation Switch (MIS)** (check all that have been completed)

Received/Built       Purchased       Exact Switch selected       Switch not selected

For each action not completed, please denote anticipated completion date on the line below box

\_\_\_\_\_ Manufacturer \_\_\_\_\_ Model #

**TD1-1-13a** Photos or diagrams must be provided that show the MIS is < 3 feet from the HV source and is located after the EDS.

**TD1-1-14**

If possible, provide measurement of isolation resistance:

Case: Vehicle off, all HV components connected, measure with ohm meter from HV bus to vehicle chassis.

HV positive to vehicle chassis: \_\_\_\_\_  $\Omega$

HV negative to vehicle chassis: \_\_\_\_\_  $\Omega$

Provide values of all HV capacitor “bleed” resistors: \_\_\_\_\_  $\Omega$

**TD1-1-15**

For all HV components with a conductive enclosure/case, provide resistance values measuring from the case to the vehicle chassis:

HV Battery case-to-chassis: \_\_\_\_\_  $\Omega$

Traction inverter case-to-chassis: \_\_\_\_\_  $\Omega$

Dc/dc converter case-to-chassis: \_\_\_\_\_  $\Omega$

Electric motor case-to-chassis: \_\_\_\_\_  $\Omega$

HV Component 1 case-to-chassis: \_\_\_\_\_  $\Omega$

HV Component 2 case-to-chassis: \_\_\_\_\_  $\Omega$

**TD1-1-16**

Please provide details on prevention of erroneous (both uncontrollable and unintended) propulsion of the e-drive system. Additionally, provide full details on vehicle safety mechanisms and reaction to these erroneous propulsion events. It is important to note that OEMs are required to meet ECE R100 (“Unintentional acceleration, deceleration, and reversal of the drive train shall be prevented. In particular, a failure (e.g. in the power train) shall not cause more than 0.1 m movement of a standing un-braked vehicle.”)

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**TD1-1-17**

Please describe in detail your short-circuit, over-current, over-voltage, over-temperature, runaway motor (loss of speed sensor), and loss of low voltage (supplying your controller) protection strategy. The description should include control diagrams and software description if depending on software for protection. If providing a hardware means, all schematics should be provided. Please provide any Hardware-in-the-Loop (HIL) results if available.

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**TD1-1-18 Solar Array (if applicable)**

_____	Manufacturer	_____	Model #
_____	Cell Material	_____	Nominal_Cell
_____	Efficiency	_____	Nominal_Cell
_____	Nominal_Cell Voltage	_____	Nominal_Cell
_____	Current	_____	Nominal_Panel
_____	Nominal_Panel Voltage	_____	Nominal_Panel
_____	Current	_____	Nominal_Panel
_____	Nominal_Cell Efficiency	_____	Nominal_Panel
_____	Efficiency	_____	Nominal_Panel
_____	# Cells	_____	# Cells per String
_____	# Strings per	_____	Panel

Status of Solar Array

<input type="checkbox"/> Received	<input type="checkbox"/> Purchased	<input type="checkbox"/> Selected	<input type="checkbox"/> not selected
_____	_____	_____	_____

For each action not completed, please denote anticipated completion date on the line below box

Please provide a description of your solar array and how the energy is used on the vehicle. Also include information on how the energy from the panel will be monitored.

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**TD1-1-19 Required Documentation**

Teams are asked to submit all forms in a single pdf file, with each pfd item identified by its associated ID (ie: TD1-1-19a).

**TD1-1-19a**  ESS specification sheet

**TD1-1-19b**  ESS manufacturer provided MSDS

**TD1-1-19c**  CAD level technical drawing(s) of ESS showing cell placement within pack, sensor placement, wire routing etc.

**TD1-1-19d**  Photo(s) of ESS showing cell placement pack, sensor placement, wire routing etc.

**TD1-1-19e**  Technical drawing(s) of ESS showing battery placement and wire routing within vehicle

**TD1-1-19 f**  Photo(s) of ESS showing battery placement and wire routing within vehicle

**TD1-1-19g**  Electrical schematic(s) of ESS showing fuses, contactors, switches, sensors, shunts, etc

**TD1-1-19h**  Technical drawing(s) of battery enclosure showing battery placement within vehicle, mounting points, etc.

**TD1-1-19i**  Calculations or finite element analysis showing the ESS enclosure can withstand crash safety requirements listed in the Technical Specifications (XXX)

**TD1-1-19j**  Teams must provide a BMS specification sheet either from the manufacturer or their own

**TD1-1-19k**  Attach charger specification sheet from the manufacturer to this report.

**TD1-1-19m**  Attach solar array specification sheet from the manufacturer to this report



## Section TD1-2

### Fueling System Specifications <sup>(1)</sup>

#### TD1-2-1 Fuel Type—Mark all fuels the vehicle will use during the competition

Gasoline     Diesel     Biodiesel \_\_\_\_\_ % Biodiesel  
 E85     CNG     Other \_\_\_\_\_

**NOTE: Teams must finalize their fuel choice by the Second Technical Deliverable. No changes will be allowed after this date.** Teams may use multiple fuels during the competition. However, the vehicle must pass all tests using all fuels, especially the emissions test. Teams not using PIAXP provided fuels are asked to contact that Fueling Director directly to coordinate fueling supplies.

#### TD1-2-2 Liquid Fuel Tank

Primary Tank  
\_\_\_\_\_ Volume (gal)    \_\_\_\_\_ Dimensions (in)  
\_\_\_\_\_ Manufacturer    \_\_\_\_\_ Model #

A vehicle's primary tank must be installed throughout the competition, but drained of all fuel and completely disconnected from the fuel system.

#### PIAXP Competition Tank

Horizontal (approx 13" x 13" x 8.5")     Vertical (approx 8.5" x 8.5" x 15")     Custom

**NOTE: Teams must select a PIAXP Competition Tank by the First Technical Deliverable.** Custom tanks will be considered on a case by case basis. Teams will be required to have the tank designed and manufactured at a PIAXP certified vendor, and teams are responsible for all costs. Teams desiring custom tanks must contact the PIAXP organizers by First Technical Deliverable and have their tank design PIAXP approved by Second Technical Deliverable.

#### TD1-2-3 Gaseous Fuel Tank

\_\_\_\_\_ Max. Pressure (bar)    \_\_\_\_\_ Dimensions (m)  
\_\_\_\_\_ Volume (l)    \_\_\_\_\_ Tank Material  
\_\_\_\_\_ Manufacturer    \_\_\_\_\_ Model #

Teams using CNG are required to use an NGV1 receptacle, and all fueling components prior to the high pressure regulator must be rated to at least 250 bar (3600 psi). Teams using gaseous fuels are asked to contact that Fueling Director directly to coordinate fueling supplies.

Pressure Sensor

\_\_\_\_\_Manufacturer \_\_\_\_\_Model #

\_\_\_\_\_Type

\_\_\_\_\_Resolution (0.1bar or 1 psi minimum)

\_\_\_\_\_Accuracy @ Full Scale (1% minimum)

Temperature Sensor\*

\_\_\_\_\_Manufacturer \_\_\_\_\_Model #

\_\_\_\_\_Type

\_\_\_\_\_Resolution (0.1 C)

\_\_\_\_\_Accuracy @ Full Scale (1% minimum)

\*Temperature sensor must read actual gas temperature inside tank

#### **TD1-2-4 Required Documentation**

Teams are asked to submit all forms in a single pdf file.

**TD1-2-4a**  Primary tank manufacturer specification sheet

**TD1-2-4b**  Vehicle schematics or drawings (front, top/bottom, side) showing the fuel system. The drawings should show the placement of tank, fueling lines, and all other fuel components (filters, pumps, etc.)

**TD1-2-4c**  Photograph(s) of competition fuel tank clearly showing mounting brackets, fittings, and hoses

**TD1-2-4d**  Photograph or video of fuel system

**TD1-2-4e**  Fuel MSDS (not required for gasoline, diesel, biodiesel, E85, CNG, or hydrogen)

**TD1-2-4f**  Pressure and temperature sensor specification sheets (gaseous fuels only)



## Section TD1-3

### Powertrain Specifications (v2)

**TD1-3-1 Powertrain Type**—Mark one appropriate powertrain that best describes the vehicle to be used during the competition

- |                                      |                                      |  |   |
|--------------------------------------|--------------------------------------|--|---|
| <input type="checkbox"/> ICE         | <input type="checkbox"/> HEV Series  | <input type="checkbox"/> HEV Parallel  | <input type="checkbox"/> HEV Series/Parallel  |
| <input type="checkbox"/> BEV         | <input type="checkbox"/> PHEV Series | <input type="checkbox"/> PHEV Parallel | <input type="checkbox"/> PHEV Series/Parallel |
| <input type="checkbox"/> Other _____ |                                      |  |   |

**TD1-3-2 Drive Type**  2 Wheel  4 Wheel  Other  
\_\_\_\_\_

#### Powertrain Status

Please mark all that apply to your powertrain.

#### TD1-3-3 ICE

Manufacturer \_\_\_\_\_ Model \_\_\_\_\_

Cylinders \_\_\_\_\_ Displacement (cu in) \_\_\_\_\_

Type (V, inline, DOHC etc.) \_\_\_\_\_ Fuel \_\_\_\_\_

Fuel System (Multiport, Direct Injection, etc) \_\_\_\_\_ Turbocharged? \_\_\_\_\_

Power (hp) \_\_\_\_\_ @ \_\_\_\_\_ rpm Torque(ft-lbs) \_\_\_\_\_ @ \_\_\_\_\_ rpm

Status of ICE (check all that have been completed)

- |                                   |                                   |  |                                    |
|-----------------------------------|-----------------------------------|--|------------------------------------|
| <input type="checkbox"/> Complete | <input type="checkbox"/> Building | <input type="checkbox"/> Design Complete | <input type="checkbox"/> Designing |
| _____                             | _____                             | _____                                    | _____                              |

For each action not completed, please denote anticipated completion date on the line below box

Please provide a detailed description of your engine including any changes from original stock engine and features that may improve performance, efficiency, or emissions. If engine is turbocharged, please provide details, such as manufacturer, make, etc.

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**TD1-3-4 Transmission**

Manufacturer \_\_\_\_\_ Model \_\_\_\_\_  
Gears \_\_\_\_\_ Type (manual, automatic, etc) \_\_\_\_\_

Status of transmission (check all that have been completed)

Complete       Building       Design Complete       Designing  
\_\_\_\_\_

For each action not completed, please denote anticipated completion date on the line below box

Please provide a detailed description of your transmission including any changes from original stock engine and features that may improve performance and efficiency.

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**TD1-3-5 Electric Motor 1**

Manufacturer \_\_\_\_\_ Model \_\_\_\_\_

Type \_\_\_\_\_ Total quantity of this motor type \_\_\_\_\_

Power (hp) \_\_\_\_\_ @ \_\_\_\_\_ rpm      Torque(ft-lbs) \_\_\_\_\_ @ \_\_\_\_\_ rpm

Max operating Voltage \_\_\_\_\_ Max operating current \_\_\_\_\_

Max. Regenerative braking current \_\_\_\_\_

Status of electric motors (check all that have been completed)

Complete       Building       Design Complete       Designing  
\_\_\_\_\_

For each action not completed, please denote anticipated completion date on the line below box

**TD1-3-6 Electric Motor 2 (if more than one type of electric motor)**

Manufacturer \_\_\_\_\_ Model \_\_\_\_\_

Type \_\_\_\_\_ Total quantity of this motor type \_\_\_\_\_

Power (hp) \_\_\_\_\_ @ \_\_\_\_\_ rpm      Torque(ft-lbs) \_\_\_\_\_ @ \_\_\_\_\_ rpm

Max operating voltage \_\_\_\_\_ Max operating current \_\_\_\_\_

Max. Regenerative braking current \_\_\_\_\_

Status of electric motors (check all that have been completed)

Complete       Building       Design Complete       Designing

For each action not completed, please denote anticipated completion date on the line below box

**TD1-3-7 Traction Inverter**

Manufacturer \_\_\_\_\_ Model \_\_\_\_\_

Power switch type \_\_\_\_\_ Switching frequency \_\_\_\_\_

Max operating voltage \_\_\_\_\_ Max operating current \_\_\_\_\_

Max operating temperature \_\_\_\_\_ Inverse diode max operating current \_\_\_\_\_

Status of traction inverter (check all that have been completed)

Complete       Building       Design Complete       Designing

For each action not completed, please denote anticipated completion date on the line below box

**Additional Information**

**TD1-3-8 Powertrain and Control Strategy**

Please provide a detailed description of the operation of your powertrain and its control strategy. Include how power is transferred from the motor/engine to the wheels. For all hybrid vehicles, describe the operation of your powertrain during both charge depleting and charge sustaining modes. If a parallel hybrid vehicle, please provide how power is provided during different operating conditions (high torque, low speed, high speed, etc.) and how the control system and transmission blends the power from the engine and motor together. For series hybrids, please describe how the system determine when to turn on the engine and how the load of the engine is controlled during different operating conditions (high torque, low speed, high speed, etc.).

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**TD1-3-9 Other Powertrain Components**

Please provide any information on any other major powertrain components:

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**TD1-3-10 Vehicle Communication**

Please mark all of the communication networks on your vehicle:

- CAN
- LIN
- J1850
- Analog Signals
- Other\_\_\_\_\_

For CAN signals, please indicate the vehicle connector used (i.e., J1962):

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For analog signals, please indicate the voltages of the signals:

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**TD1-3-11 Emissions**

NOx (g/mi)\_\_\_\_\_ (tested/estimated)

CO (g/mi)\_\_\_\_\_ (tested/estimated)

NMHC (g/mi)\_\_\_\_\_ (tested/estimated)

PM (g/mi)\_\_\_\_\_ (tested/estimated)

Status of emissions system (check all that have been completed)

- Complete
- Building
- Design Complete
- Designing

For each action not completed, please denote anticipated completion date on the line below box

Please provide a detailed description of the operation of your emissions equipment and emissions control strategy. Include how emissions levels of all criteria pollutants will be controlled under different operating conditions (high torque, low speed, high speed, cold start etc.) and vehicle modes (charge depleting and charge sustaining modes for hybrid vehicles). Also include a description on the status of your equipment, including any testing that has been done.

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**TD1-3-12 Required Documentation**

Teams are asked to submit all forms in a single pdf file.

**TD1-3-12a**  Original engine specification sheet

**TD1-3-12b**  Original transmission specification sheet

**TD1-3-12c**  Original motor specification sheet

**TD1-3-12d**  Photos of powertrain, including engine, motor, and transmission mounted within vehicle

**TD1-3-12e**  A technical drawing(s) of the powertrain showing all major components and power flow during different operation conditions

**TD1-3-12f**  Certified test data from emissions testing

## Section TD1-4

# Body and Chassis System Specifications

### TD1-4-1 General Information

Doors \_\_\_\_\_ Seats \_\_\_\_\_ Material \_\_\_\_\_

Wheelbase (in) \_\_\_\_\_ Width (in) \_\_\_\_\_ Height (in) \_\_\_\_\_

Ground Clearance (in) \_\_\_\_\_ Curb Weight (lbs) \_\_\_\_\_

Original GVW (lbs) \_\_\_\_\_ (for modified production vehicles)

Modified Production Vehicle (continue below)     New Construction (Skip to New Construction section)

### MODIFIED PRODUCTION VEHICLES:

TD1-4-2 Base vehicle manufacturer and model \_\_\_\_\_ Year \_\_\_\_\_

Status of Chassis Structure (check all that have been completed)

Received                       Purchased                       Exact Chassis selected  
\_\_\_\_\_

For each action not completed, please denote anticipated completion date on the line below box

Status of Modifications to Chassis Structure (check all that have been completed)

No Modifications planned                       Modifications complete                       Modifications Started  
\_\_\_\_\_

Design and analysis complete                       Design started                       Design Not Started  
\_\_\_\_\_

For each action not completed, please denote anticipated completion date on the line below

### TD1-4-3 Detailed description of modifications to structure:

(Include details regarding how the modifications are expected to maintain or improve structural integrity of the original equipment, especially with regard to changes in weight, placement of major components, and reduction in crush zones. regarding material selection, structural member sizing, attachment scheme, and load path confirmation.

NOTE: **Must include pictorial representation of entire structure with notations for sizing, thickness, materials, attachment, etc.** Pictorial can be CAD screen plot, scanned drawings, photos, etc.)

**Chassis Structural Engineering for Modifications** (check all that have been completed and are attached)

- Calculations       Finite Element Analysis       Other Simulation       None
- 

For each action not completed, please denote anticipated completion date on the line below box

**Pictorial Representation of Modifications** (check all that have been completed and are attached)

- CAD picture       Scanned drawings       Hand drawings       Photos
- 

**Details of Modifications** (check all that have been completed and are attached)

- Material specs
- 

- Structural member sizing relative to replaced original equipment (Pictorial required with notations for section size, thickness, material, etc.)
- 

**Section Representations** (Include pictorial showing dimensions, thickness, material for the following cross sections)

- |  |   |
|--|---|
| <input type="checkbox"/> Front/Motor compartment rail              | <input type="checkbox"/> Rocker/Door sill                                 |
| <input type="checkbox"/> A-pillar/Windshield side member           | <input type="checkbox"/> Roof side rail/door header                       |
| <input type="checkbox"/> Front hinge pillar                        | <input type="checkbox"/> B-pillar/Lock pillar                             |
| <input type="checkbox"/> Rear compartment rail                     | <input type="checkbox"/> Rear roof header/roll hoop                       |
| <input type="checkbox"/> Front of dash cross-car members           | <input type="checkbox"/> Seat back/rear bulkhead (structure behind seats) |
| <input type="checkbox"/> Front bumper beam                         | <input type="checkbox"/> Rear bumper beam                                 |
| <input type="checkbox"/> Under-floor longitudinal support          | <input type="checkbox"/> Under-floor cross car support/seat bars          |
| <input type="checkbox"/> Door beam(s) and interface with structure | <input type="checkbox"/> Other  |

**Attachment scheme for modifications**

- Bolted       Welded       Bonded

Details:

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**Modified Vehicles skip to "ALL VEHICLES" sections below.**

**NEW CONSTRUCTION VEHICLES:**

**TD1-4-4 Status of Chassis Structure:** (check all that have been completed)

- Complete     Construction started     Design complete     Design started
- 
- 

For each action not completed, please denote anticipated completion date on the line below box

**TD1-4-5 Detailed description of structure:**

(Required documentation includes calculations, simulation, Finite Element Analysis, etc. used to make decisions regarding material selection, structural member sizing, attachment scheme, and load path confirmation. Must include pictorial representation of entire structure with notations for sizing, thickness, material, attachment, etc. Pictorial can be CAD screen plot, scanned drawings, photos, etc.)

**Pictorial Representation of Chassis Structure:** (check all that have been completed and are attached)

- CAD picture     Scanned drawings     Hand drawings     Photos
- 
- 

**Details of Structure** (check all that have been completed and are attached)

- Material specs
- 

**Section Representations** (Include pictorial showing dimensions, thickness, material for the following cross sections)

- |  |   |
|--|---|
| <input type="checkbox"/> Front/Motor compartment rail            | <input type="checkbox"/> Rocker/Door sill                                 |
| <input type="checkbox"/> A-pillar/Windshield side member         | <input type="checkbox"/> Roof side rail/door header                       |
| <input type="checkbox"/> Front hinge pillar                      | <input type="checkbox"/> B-pillar/Lock pillar                             |
| <input type="checkbox"/> Rear compartment rail                   | <input type="checkbox"/> Rear roof header/Roll hoop                       |
| <input type="checkbox"/> Front of dash cross-car members         | <input type="checkbox"/> Seat back/Rear bulkhead (structure behind seats) |
| <input type="checkbox"/> Front bumper beam                       | <input type="checkbox"/> Rear bumper beam                                 |
| <input type="checkbox"/> Under-floor longitudinal support        | <input type="checkbox"/> Under-floor cross car support/Seat bars          |
| <input type="checkbox"/> Door beam(s) and interface to structure | <input type="checkbox"/> Other  |

**Attachment scheme for modifications**

- Bolted     Welded     Bonded

Details:

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**ALL VEHICLES:**

**TD1-4-6 Detailed description of plan to meet FMVSS Crashworthiness Requirements:**

(Reference <http://www.nhtsa.dot.gov/cars/rules/standards/> for details regarding specific requirements. Per the PIAXP Guidelines, compliance with the following is required: FMVSS 201, 205, 208, 209, 210, 212, 214, 216, 301. Include calculations, simulation, Finite Element Analysis, etc. as means to demonstrate how engineering decisions were made in the design of “crush zones” and protection of vehicle occupants per US Federal standards. Of specific concern is verification that fuel systems and occupants will not be in the intrusion zones for front, rear or side impact. Please include a description of any non-structural components that may reside within crash intrusion zones and explain their interaction during a crash event – i.e. contributing to crush resistance or deflect out of the way, etc.)

**Pictorial Representation of ENTIRE Structure** (check all that have been completed and are attached)

- CAD picture                       Scanned drawings                       Hand drawings                       Photos
- \_\_\_\_\_

**TD1-4-7 FMVSS Requirements** (check all that have been completed. If not complete, please indicate anticipated completion date. )

**Crashworthiness Engineering Assessment:** (check all that have been completed and are attached)

- Calculations                       Finite Element Analysis                       Other Simulation                       None
- \_\_\_\_\_

For each action not completed, please denote anticipated completion date on the line below box

- |   | Expected Completion Date |
|---|--------------------------|
| <input type="checkbox"/> FMVSS 201 – Occupant Protection on Interior Impact | _____                    |
| <input type="checkbox"/> FMVSS 205 – Glazing Materials                      | _____                    |
| <input type="checkbox"/> FMVSS 208 – Occupant Crash Protection              | _____                    |
| <input type="checkbox"/> FMVSS 209 – Seat Belt Assemblies                   | _____                    |
| <input type="checkbox"/> FMVSS 210 – Seat Belt Anchorage                    | _____                    |
| <input type="checkbox"/> FMVSS 212 – Windshield Mounting                    | _____                    |
| <input type="checkbox"/> FMVSS 214 – Side Impact Protection                 | _____                    |
| <input type="checkbox"/> FMVSS 216 – Roof Crush Resistance                  | _____                    |
| <input type="checkbox"/> FMVSS 301 – Fuel System Integrity                  | _____                    |

## **ALL VEHICLES:**

### **TD1-4-8 Required Documentation**

Teams are asked to submit all forms in a single pdf file.

**TD1-4-8a**  CAD level technical drawing(s) of Chassis Structure showing packaging of structural and non-structural components.

**TD1-4-8b**  Photos of chassis in current state if construction.

**TD1-4-8c**  Calculations, simulation results, or Finite Element Analysis report regarding structural integrity and crashworthiness.

## **Section TD1-5**

### **Current Performance, Measurements, & Specs**

(No information required in this Section for First Technical Deliverable)

This concludes the Template for Submitting Data  
for the First Technical Deliverable (TD1).

*Include Separate File for All Required Photos, Diagrams, etc.,  
Each one in PDF format*