



PENNSTART  
REQUIREMENTS  
EXECUTIVE SUMMARY

November 2020



# Executive Summary

The Pennsylvania Safety Transportation and Research Track (PennSTART) is a proposed comprehensive high-speed test track and transportation research, testing, and training facility, which is designed to accelerate innovation in emerging transportation technology. PennSTART is planned on a 110-acre site. Follow-up conversations with stakeholders resulted in a more thorough needs analysis. The PennSTART facility concept is spearheaded by a core team from Pennsylvania Department of Transportation (PennDOT) and Pennsylvania Turnpike Commission (PTC) in partnership with Pennsylvania State University (PSU).

This Systems Requirements document is intended to document and prioritize the requirements that drive the specifications, design, development, implementation, integration and testing of the Pennsylvania Safety Transportation and Research Track (PennSTART) facility. The requirements and associated priorities are anticipated to be further refined during the design and construction phases depending on available funding, availability of land, and additional stakeholder comments.

The System Requirements were developed by starting with the user needs from the Concept of Operations and developing a list of functions and features that PennSTART must have. This list of requirements was presented to focus groups at a workshop to verify whether the requirements will meet the users' needs. Feedback from the focus groups was used to refine the requirements and come up with the final requirements.

Following the refinement of requirements, the project core team identified preliminary requirement priorities. Various aspects of functionality such as project goals, importance, risk, costs etc., were considered. Based on the prioritization of requirements and the funding availability, the construction phases and the features that will be developed during each of the construction phase were determined.

It is anticipated that the initial phase of construction will include, the test loop, high-speed section, truck turnaround (open area), toll gantries, maintenance shed, parking lot, six-lane section, urban intersection, signalized urban corridor, roundabout, city section, rural intersection, high-speed rural intersection, bridge section, ramp meters, truck parking and staging area, active traffic management system, railroad at-grade crossing, and heliport. During the future phases, academic building, weather simulator, aircraft rescue firefighting and training simulator, and a tunnel section.

High level requirements for PennSTART are identified below in the general order of priority.

## **Initial Phase:**

### **General:**

- Entire facility shall have Wi-Fi coverage.
- Entire facility shall be digitally mapped.
- Entire facility shall have lighting.

- Entire facility shall have adequate storm sewer drainage for a design year storm that complies with local municipal land development requirements.
- All roadway grading shall comply with AASHTO: A Policy on Geometric Design of Highways and Streets, 7th Edition.
- Entire facility shall be surrounded by an 8' minimum fence that provides both privacy and security.
- All buildings, equipment, and gates shall have locking mechanism.
- All communications infrastructure on the project shall be connected to the server room via multiple backhaul methods (i.e. fiber and 4G).
- All communications infrastructure shall have an internet connection.
- All communications infrastructure shall have conditioned power.
- Facility shall have standpipes located throughout the facility
- Facility shall have safety zones where trainees and personnel can stand directly next to the track and training facility components.
- The facility shall have an area dedicated to storing pre-crashed and un-crashed vehicles for training scenarios.
- The facility shall have at least two (2) movable simulated utility poles and wires around the track that can be downed onto the roadway and reset.
- All facility components that have applicable CV applications shall have licensed RSUs operating in the 5.9 GHz band.
- The facility shall have radio communication system.
- Roadways in the facility shall contain various grades.
- Facility shall be oriented to allow for testing the impacts of sunlight on the roadside environment.
- Entire facility shall have CCTV cameras to provide complete visual coverage of the track from the control center
- Pavement shall look distressed using pavement marking removal/tapes at some locations.
- The facility shall have oversize ground cabinets wherever hardware may need to be tested.
- The facility shall have pavement markings.
- The track shall include portable visual obstructions that are capable of obstructing sight distance around curves and straight sections of roadway.
- The facility shall have storage space of various training equipment
- The facility shall have landscaping elements (e.g. trees).
- The facility shall have survey benchmark(s).
- The facility should be at least Leadership in Energy and Environmental Design (LEED) silver certified.
- The facility shall have vehicle refueling port.
- Track users shall have the ability to schedule through a scheduling platform.

#### **Test Loop:**

- The test loop shall be paved.
- At least one lane of the test track shall comply with AASHTO: A Policy on Geometric Design of Highways and Streets, 7th Edition.
- Test track shall have an accurate weigh-in-motion system.
- Test track shall have an area off the main loop that has an unpaved roadway.
- Test track shall have a simulated section of noise wall.

**High-Speed Section:**

- The test track must have a section dedicated up to 100 mph testing (desirable).
- The high-speed testing area shall have a straight geometry with no curves.
- Users must be able to reach 100 mph for passenger vehicles on the straight sections under the overhead tolling gantries (desirable)
- Users must be able to reach 40 mph for heavy vehicles speed on curves.
- The high-speed testing area shall be able to have the traffic direction reversed. (Speeds and operational parameters required for primary direction do not need to be maintained in the reverse direction)
- The high-speed testing area shall be equipped with pavement RWIS.
- The high-speed testing area shall have a variety of moveable barriers.
- The high-speed testing area shall have fire hydrants.

**Truck Turnaround (Open Area):**

- Truck turnaround area shall be paved.
- Truck turnaround area shall have sufficient space for a WB-65 to make a U-turn.
- Truck turnaround area shall be appropriately striped.

**Toll Gantries:**

- Test track shall have two oversized gantries for tolling purposes to accommodate multiple toll equipment.
- The two toll gantries shall be back to back.
- Gantries shall extend over all lanes of traffic.
- The gantries shall be designed for an under clearance that is suitable for overheight trucks.
- Two toll gantries shall be placed 36' apart, center-to-center.
- Gantries shall have wireless communication connections to the server.
- Gantries shall be located on the straight section of track closest to the server room.
- Gantries shall support the addition and/or removal of future equipment.
- Gantries shall be equipped with PTC standard license plate readers.
- Gantries shall have several cellular network provider connections.
- Gantries shall have space frames between the two gantry structures.
- The gantries shall have wireline connections to nearby ground cabinets.
- Gantries shall have poles to mount side-fire cameras.
- Concrete pads shall be located upstream of the gantries.

**Maintenance Shed:**

- Maintenance shed shall have an office area
- Maintenance shed parking lot shall be sized to accommodate the number of visitors and users of the facility.
- Maintenance Shed shall have a test bench area.
- Maintenance Shed shall have temporary classroom space until the Academic Building is complete.
- Maintenance shed shall have outdoor storage space for portable gantries.
- Maintenance Shed shall have outdoor storage space for CONEX boxes.

- Maintenance Shed shall have a UAV workshop.

**Parking Lot:**

- Parking lot shall be sized to accommodate the number of visitors and users of the facility.
- Parking lot shall be flexible to allow for future expansion once the academic building is constructed
- Parking lot shall be striped.
- Parking lot shall be paved.
- Parking lot shall have power connection.
- Parking lot shall have electric vehicle charging stations.
- Parking lot shall have a painted and measured Pennsylvania State Police motorcycle driver training course.

**Six-Lane Section:**

- Test track shall have at least one ramp merging onto the mainline.
- Test track shall have at least one ramp diverging from the mainline.
- 6-Lane Highway Section, including on- and off-ramps, shall have space to place simulated building facades to create an urban core.

**Urban Intersection:**

- The urban 4-point intersection shall be paved.
- The urban 4-point intersection shall include 4 entry points.
- The urban intersection shall consist of the appropriate radii as specified in PennDOT Publication 13M, Design Manual, Part 2, Chapter 2, Highway Design, Sections 2.6 and 2.7.
- The urban 4-point intersection shall include mast arms, traffic signal controllers, and oversized controller cabinets.
- The urban 4-point intersection shall provide pedestrian crosswalk.
- The urban 4-point intersection shall include appropriate signage (e.g. stop, yield, lane control).
- The urban 4-point intersection shall include a variety of detection systems.
- The urban 4-point intersection shall include traffic signal heads, pedestrian signal heads, and bicycle signal heads.

**Signalized Urban Corridor:**

- Intersection and adjoining roadway will be designed to standards for WB-67 AASHTO design vehicles and up to 35 MPH
- Signalized corridor shall simulate streetscape for transit testing, including bus shelters.
- Signalized corridor shall simulate streetscape for pedestrian testing including crosswalks.
- Signalized corridor shall simulate streetscape for bicycle testing including bicycle lanes/facilities.
- Signalized corridor shall simulate streetscape for freight, drop-off/delivery testing.
- Signalized corridor shall simulate streetscape for parking and access points.
- Signalized corridor shall simulate streetscape for passenger drop-off.
- Signalized intersections shall be operable with CV technology (DSRC and C-V2X)
- The signalized corridor shall have multiple signals built using the requirements from urban 4-point intersection component.

- The signalized urban corridor controller cabinets shall be connected via fiber.
- The signalized urban corridor shall have simulated low hanging wires.

**Roundabout:**

- The 4-point roundabout shall be paved.
- The 4-point roundabout shall be designed with 2 travel lanes.
- The 4-point roundabout shall have a truck apron.
- The 4-point roundabout shall be designed to include a pedestrian crosswalk located around the perimeter of the roundabout.
- The 4-point roundabout shall be designed to include a bicycle path located outside of the roundabout.

**City Section:**

- Training facility shall have a city simulation component.
- The city simulation shall be paved
- The city simulation shall consist of the appropriate radii as specified in PennDOT Publication 13M
- The city simulation shall consist of a multilane section.
- The city simulation shall include parallel parking spaces.
- The city simulation shall include a one-way section.
- The city simulation shall include an alley way section.
- The city simulation shall include simulated building facades.
- The city simulation shall be able to accommodate articulated buses and WB-65 trucks.
- The city simulation shall include sidewalks.
- The city simulation shall have a mountainous section.
- The city simulation shall have a high-speed section.
- High-speed city section shall have parallel parking.
- City simulation shall simulate streetscape for bicycle testing including bicycle lanes/facilities.
- City simulation shall simulate streetscape for freight, drop-off/delivery testing.
- City simulation shall simulate streetscape for parking and access points.
- City simulation shall simulate streetscape for passenger pick-up/drop-off.
- City simulation shall include appropriate signage (e.g. stop, yield, lane control).
- City simulation shall simulate streetscape for transit testing.

**Rural Intersection:**

- The rural intersection shall be paved.
- The rural intersection shall consist of 4 entry legs.
- The rural intersection shall provide unsignalized/stop control portion with 2-way stop.
- The rural intersection shall consist of the appropriate radii as specified in PennDOT Publication 13M, Design Manual, Part 2, Chapter 2, Highway Design
- The rural intersection shall include appropriate signage.

**High-Speed Rural Intersection:**

- The High-Speed Rural Intersection shall be paved

- The intersection shall have 4 points of entry
- The intersection shall have 2 lanes of travel
- The 3-point intersection shall include mast arm, traffic signal controllers, and oversized traffic signal controller cabinets.
- High-speed rural intersection shall have one leg with wide shoulders and rumble strips and one leg with no shoulders.

#### **Bridge Section:**

- Bridge section shall be designed with vertical and horizontal alignment appropriate for WB-65 (design vehicle for truck platooning) vehicles up to 75 MPH over the bridge.
- Bridge section shall be designed for weight based on three WB-65 (design vehicle for truck platooning) at 75 MPH (per design manual)
- Bridge section pavement design shall be appropriate to test in all weather conditions
- Bridge section design shall include drainage features
- Bridge approaches will have appropriate guiderail and signage
- Bridge section will be no greater than 1000' from hydrant access with standpipe installed.
- Bridge section shall have conduit installed for fiber or power installations to roadside ITS devices
- Bridge shall be equipped with sensors for testing dynamic loading.

#### **Ramp Meters:**

- Test track shall have an on-ramp that includes a ramp metering system.
- Ramp meter system shall be designed to PennDOT Publication 646.

#### **Truck Parking and Staging Area:**

- The staging area shall be paved
- The staging area shall have 3 points of entry/exit
- Truck and Trailer parking space shall be designed for WB-65
- The staging area shall have space for parking multiple vehicles.
- Truck parking and staging area shall include an air pump for filling tires.

#### **Active Traffic Management System:**

- The track will be equipped with two oversized gantries dedicated to ATM testing and DMS testing.
- Track shall have a concrete pad near the ATM gantries
- Track shall include multiple detection technologies and techniques (e.g. loop detectors, video, and infrared) near the ATM gantries.
- ATM System gantries shall support the ability to have direction of travel reversed (e.g. support equipment mounting on both sides).

#### **Railroad At-Grade Crossing:**

- At-grade crossing shall be built to FRA specifications.
- At-grade crossing shall be equipped with emergency preemption detectors.
- At-grade crossing shall be designed to accommodate a bus at 35 mph.
- At-grade crossing shall have gates.

**Heliport:**

- A minimum of one wind cone shall be installed at an appropriate location(s) for optimum visibility for aircraft approaching the Touchdown and Lift-Off Area (TLOF).
- Wind Cone(s) shall be compliant with FAA AC 150/5345-27.
- The heliport shall comply with all fire safety requirements as stipulated in NFPA 418 – Standards for Heliports.
- The Heliport shall be outfitted with all required lighting.
- The Heliport shall employ appropriate measures to ensure the safety and security of all users.
- Heliport shall be equipped with an aviation fire extinguishers.
- Heliport shall be equipped with wheeled fire extinguishing equipment for helicopter fire protection per FAA standards.
- The Heliport shall include a communications system to coordinate activities with the adjacent airport.

**Future Phase(s):****Academic Building:**

- There shall be a building on site dedicated to academic, training, and operating activities.
- Academic Building shall be equipped with Wi-Fi.
- Academic Building shall have a classroom.
- Academic Building shall be equipped with a dedicated Traffic Management Center (TMC) laboratory.
- Academic Building shall have a multi-purpose room.
- Academic Building shall have public utility connections.
- Academic Building shall have public restrooms.
- Academic Building shall have kitchen.
- Academic Building shall have dining area.
- Academic Building shall have trash dumpster.
- Academic Building shall have three conference rooms.
- Academic building shall have a dedicated garage area.
- Academic Building shall have a tower.
- Academic Building shall have a backup generator.
- Academic Building shall meet local design codes.
- Academic Building shall meet Pennsylvania State University design guidelines.
- Academic Building shall be ADA compliant.
- Academic Building shall have a media coverage room.
- Academic Building shall have outdoor satellite truck hookup with power and local area network access.

**Weather Simulator:**

- Weather simulator shall have a water connection.
- Weather simulator shall have a power and communications connection.
- Weather simulator shall be able to be controlled remotely.
- Weather simulator shall have a hose to apply water to vehicles.
- Weather simulator shall have a pad to freeze water.



### **Aircraft Rescue Firefighting and Training:**

- Aircraft Rescue Firefighting and Training Simulator shall have a two-acre pad.
- Pad shall include a water reclamation system.
- Aircraft Rescue Firefighting and Training Simulator shall include a Liquefied Petroleum Gas fuel pump delivery system.
- Aircraft Rescue Firefighting and Training Simulator shall include a gravel training area.
- Aircraft Rescue Firefighting and Training Simulator shall have National Institute of Standards and Technology (NIST) standard fire hydrants.
- Aircraft Rescue Firefighting and Training Simulator shall have water connection.
- Aircraft Rescue Firefighting and Training Simulator shall have power connection.
- Aircraft Rescue Firefighting and Training Simulator shall have natural gas connection.
- Aircraft Rescue Firefighting and Training Simulator shall have communications connection.
- Aircraft Rescue Firefighting and Training Simulator shall have a manifold station for quick access to natural gas.
- Aircraft Rescue Firefighting and Training Simulator shall have at least two vehicle access points.
- Aircraft Rescue Firefighting and Training Simulator shall have a mobile self-contained breathing apparatus filling system.
- Aircraft Rescue Firefighting and Training Simulator shall have a decontamination station area.
- Aircraft Rescue Firefighting and Training Simulator shall have airport runway and taxiway labels and markings.
- Aircraft Rescue Firefighting and Training Simulator shall have an airport runway lighting system.
- Aircraft Rescue Firefighting and Training Simulator shall include full integrated live fire burning props, fuel supply system and control systems for multiple fire scenarios.
- Aircraft Rescue Firefighting and Training Simulator shall include computer-based ignition, control, aviation rescue and firefighting scenario management, safety monitoring and action recording systems.
- Aircraft Rescue Firefighting and Training Simulator shall include a narrow-bodied aluminum aircraft with a modified tow vehicle that doubles as a control room.

### **Future Tunnel Component:**

- The future tunnel component location shall have foundation for a tunnel.

To accommodate all the desired user needs, the estimated 110-acre site may likely be inadequate. The project core team is both prioritizing the use cases to fit within a 110-acre site and working with PennDOT, PTC and PSU to find additional infrastructure to support the use cases that cannot be accommodated on the proposed site.