



**SUBJECT:** CALSTART Request for Information (RFI)

**TOPIC:** Next-Generation, Purpose-Built, Transit Automated Vehicle

**RESPONSE DEADLINE:** Monday, June 15, 2020 at 5:00 PM PST



Maryland Transportation Authority



**RFI SUBMISSION:** RFI response submissions for the Next-Generation, Purpose-Built, Transit Automated Vehicle (AV) will be received by CALSTART until the above-stated response deadline at the following electronic address:

Maureen Marshall - CALSTART Midwest Regional Director

[mmarshall@calstart.org](mailto:mmarshall@calstart.org)

Subject Line: CALSTART Next Generation, Purpose-Built, Transit AV Submission

**QUESTION & ANSWERS:**

All questions or concerns regarding this RFI must be submitted electronically to [mmarshall@calstart.org](mailto:mmarshall@calstart.org) prior to 5:00 PM PST on Friday, May 22, 2020. Please visit [www.catuf.org](http://www.catuf.org) to access the RFI, news and notices, and a listing of questions and answers. A webinar will be held on Wednesday, May 13, 2020 to review the RFI and provide an opportunity to address questions. All questions and answers will be collected and distributed to all interested parties to the RFI by Friday, June 5, 2020.

**ABOUT CALSTART:**

CALSTART is a nonprofit organization working nationally and internationally with businesses and governments to develop clean, efficient transportation solutions. CALSTART connects companies and government agencies and helps them work more efficiently. From technology firms to transit operators and from vehicle manufacturers to research institutions, CALSTART connects every sector of industry. It effectively offers customized services, information and technologies.

**SUMMARY:**

In 2018, CALSTART initiated the Connected and Automated Transportation Users Forum (CATUF) to begin to address the many needs and questions regarding AV technology of its members and the larger transit community. Recognizing that there was a critical need from the transit community to focus not only on automated technology development but also key transit operational requirements that include vehicle crashworthiness and accessibility, a cohort of transit stakeholders was created to tackle these needs.

This RFI reflects the interest across a selection of transit stakeholders; a large majority being operators of public transportation. These entities operate a wide

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variety of geographical areas under differing environmental circumstances. This solicitation, by providing critical Key Performance and Design Parameters (KPPs) of this next-generation, purpose-built, transit automated vehicle, is a request to industry to think creatively, innovatively and pragmatically to bring about a new mobility solution for transit operators to address existing challenges of public transportation.

### **BACKGROUND:**

The mobility ecosystem is rapidly changing, and automation is quickly emerging as a commercially available solution for use in future transportation systems from automobiles, buses, shuttles and more. In fact, many transit agencies and State Departments of Transportation have great experience already deploying pilot-based connected and automated vehicle technologies.

Recognizing this, in 2018, CALSTART initiated the CATUF user's forum to begin to address the many needs and questions regarding the AV technology of its members and the larger transit community. As part of this activity, CALSTART organized webinars, one-on-one interviews and conducted presentations, while also collecting stakeholder feedback on the critical gaps and needs for the future transit industry. Through this effort, it was identified that the critical needs of transits and mobility providers around AV pilot activities was not being met. This led to the establishment of a cohort of transit stakeholders to develop consensus on KPPs, potential vehicle specifications and design guidelines in the Fall of 2019.

CALSTART, in coordination with the CATUF Transit Cohort,<sup>1</sup> have identified unique needs or KPPs that are necessary to satisfy both transit operations and community members whom are served by public transportation. It is the goal of the cohort to provide better transit services with a vehicle solution that holistically meets these diverse needs. However, that vehicle does not currently exist in the marketplace. Therefore, the cohort intends for this work to lead to a potential procurement of approximately twenty (20) to thirty-five (35) first-generation, purpose-built, transit-ready AVs. These vehicle procurements could be requested as early as late 2020 or as funds become available and are planned to be delivered by mid-to-late 2022.

This RFI is as a call to action and dialog out to the larger community about the needs of a next-generation, purpose-built, transit AV for use in designated public transportation.<sup>2</sup> Due to the unique requirements of public transit, including, but not limited to adherence to the Americans with Disabilities Act,<sup>3</sup> Buy America<sup>4</sup> and stringent safety guidelines,<sup>5</sup> this task comes with a set of mandatory KPPs. To operate effectively, transit must also work in diverse operational environments requiring a variety of vehicle sizes and form factors. This includes the need for transit vehicles to meet federal bus testing<sup>6</sup> for performance, structural integrity, reliability and

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<sup>1</sup> While the CATUF initiative includes a larger group of transit industry stakeholders, specific entities entered into a Memorandum of Cooperation with CALSTART to conduct work which has led to the creation of this RFI. Transit stakeholders in this effort include: Access LA, CCTA, COTA, GET, JTA, MDOT, MDTA, RTC, RTD, SARTA, SCVTA, TARTA, UTA and WRTA.

<sup>2</sup> <https://www.law.cornell.edu/cfr/text/49/37.3>

<sup>3</sup> <https://www.transit.dot.gov/regulations-and-guidance/civil-rights-ada/americans-disabilities-act>

<sup>4</sup> <https://www.transit.dot.gov/buyamerica>

<sup>5</sup> <https://www.transit.dot.gov/regulations-and-guidance/safety/transit-safety-oversight-tso>

<sup>6</sup> <https://www.transit.dot.gov/research-innovation/bus-testing>

durability. As transit evolves to new vehicle form factors, the Federal Motor Vehicle Safety Standards (FMVSS) also currently apply.<sup>7</sup>

Vehicle automation is promising technology that deserves investment and if developed and applied appropriately, automation can be a highly effective means to help alleviate some of the challenges of public transportation and provide great benefits to the future of transit – safety, efficiency, convenience and economic and societal benefits – while providing mobility for all. This RFI communicates the needs as a means to inspire innovative responses from industry stakeholders who understand public transportation is at the heart of tomorrow's mobility system.

### **PURPOSE AND INTENT:**

Public agencies, commuters, transit operators and private industry struggle to identify the appropriate transportation solutions to meet the ever-growing demands for personal mobility. A variety of Low Speed Automated Vehicle (LSAV) technologies are available on the market today, which will continue to evolve over the next decade. Unfortunately, today these vehicles are not deemed crashworthy, and accessibility for people with disabilities is an afterthought. This RFI describes, promotes and informs a vehicle design and production utilizing inclusive and universal design principles encouraging the adherence to ADA and moving beyond it.<sup>8</sup>

The intent of this RFI is to begin a dialogue with vehicle vendors, manufacturers, engineers, software developers and other related transportation industries. This RFI represents the needs of a diverse set of transit stakeholders who desire to share knowledge, to inspire and invite industry to think creatively, innovatively and pragmatically to bring about a new mobility solution for transit operators. The compiled results from this RFI will assist in the development of several vehicle procurements supporting the deployment of next-generation, purpose-built, transit AV fleets across the United States.

### **SOLICITATION:**

CALSTART and the CATUF Transit Cohort are inviting all vendors, manufacturers and engineers of electric or zero-emission vehicles to respond to this RFI along with appropriate and applicable partners and to share feedback and qualifications for the delivery of a next-generation, purpose-built, transit AV using the KPPs outlined in the attached appendix.

While this RFI describes KPPs required for the next-generation, purpose-built, transit AV, it is to be descriptive of needs and not prescriptive. It is understood that there is a balance between KPPs that are must haves versus nice to have. This RFI attempts to describe what operators of public transportation require but are open to understanding what is practical, feasible and economical.

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<sup>7</sup> <https://www.nhtsa.gov/laws-regulations/fmvss>

<sup>8</sup> <http://www.buffalo.edu/access/help-and-support/topic3/universaldesignprinciples.html>

### **BASELINE KEY PERFORMANCE & DESIGN PARAMETERS:**

Attached as an appendix is a table of key performance and design parameters (KPPs) that the CALSTART CATUF Cohort, built by consensus, has deemed necessary to address in the development of the next-generation, purpose-built, transit AV.

Submissions should attempt to address all KPPs and provide adequate information and insight so that a practical and informed procurement document or Request for Proposals (RFP) can be designed for future vehicle acquisitions.

### **NOTES ON OPERATIONAL DESIGN DOMAINS (ODDs) AND TRANSIT OPERATIONS:**

Vehicles entered into commercial public transportation operations must be highly reliable and flexible in nature, accommodating many needs. The same vehicle may be used in a variety of operational design domains (ODDs) including, but not limited to, personal rapid transit, on-demand circulators, first and last mile services and paratransit services in potentially mixed-traffic in both urban and suburban areas.

Physical and infrastructure environments will also differ for the next-generation, purpose-built, transit AV. For example, the AV may operate on-street, in a pathway with dedicated lane, within an on-street pathway with a dedicated lane for shared AVs and other transit vehicles, or perhaps operate in mixed-traffic. Attention should be given to describing how the vehicle can withstand these ODDs and to what limitations, if any, exist as the vehicle is deployed.

### **NOTES ON SAFETY:**

Safety is paramount to operators of public transportation. From passenger safety to the way a vehicle detects and communicates with the environment around the vehicle (i.e., pedestrians, vehicles, cyclists) is key to safe deployment of an AV in transit applications. Considerations should be given and addressed for the following safety elements:

- Emergency braking situations
- Passenger safety
- Remote or teleoperations
- Intersection navigation
- Pedestrian detection
- Unplanned obstacle detection
- Bicycle interactions
- Mixed-traffic operations
- Two-way communication
- Evacuation ease
- First responder plan
- 360-degree object detection

### **RFI RESPONSE FORMAT:**

Please provide RFI responses organized in the manner described below with a limit of approximately 25 pages plus any pertinent appendices.

- A. **Cover Letter** – Please include all contact information including address, Point of Contact information including telephone and email address, website and brief summary of your organization and experience related to autonomous vehicle and systems development.

- B. **Body** – Clearly describe the vehicle solution(s) your organization has to offer in this space or the new vehicle(s) solution your organization would consider building in response. It is our goal to understand what the vehicle(s) would look like and how closely the KPPs can be met. Provide information on technology readiness levels (i.e., concept, prototype, pilot ready, or commercially available). Address each KPP element with your expectation to compliance. In the response, include any and all reactions, answers and considerations along with any other applicable information or insight to be considered in the construction of any future procurement documents. If you believe the KPP element is unreasonable, please provide this explanation and alternative solutions, if any. We are looking for a very detailed response to the KPPs and clear understanding as to why a particular KPP may not be met, as well as any and all possible alternative solutions.
- C. **Rough Order Magnitude Budget** – To the degree possible, please include a rough order magnitude budget and timeline associated with the delivery of the fleet of AVs described above in the RFI for the following quantities and build types: up to 3 – prototypes, up to 15 – pilots and up to 100 - production units.
- D. **Appendices** – Please include any documents which bring attention to or illuminate RFI responses or have potential educational value for the development of potential procurement documents related to the acquisition of the next-generation, purpose-built, transit AV.

#### **DOCUMENTS AND RESOURCES FOR CONSIDERATION:**

Along with the other documents footnoted in this RFI and descriptions of KPPs listed herein, other documents to help in crafting a response and advancing the notion of the next-generation, purpose-built, transit AV include:

- JTA RFI & Golden 20<sup>9</sup>
- USDOT ATTRI Program<sup>11</sup>
- APTA Public Transit Increases Exposure to AV Technology<sup>13</sup>
- FTA STAR Program<sup>10</sup>
- APTA Bus Procurement Guideline<sup>12</sup>

#### **EVALUATION CRITERIA:**

RFI responses will be evaluated based on the organization’s knowledge and background in transportation, automation, and transit, near term capabilities and ability to address each of the KPPs with innovative solutions that are achievable, while also providing details behind any KPPs that cannot be met with well-defined alternative solutions and timing.

#### **IMMEDIATE NEXT STEPS:**

Once all of the RFI responses are received and reviewed by the cohort, the top responses by organization will have an opportunity to present their solution(s) to the cohort members during a webinar opportunity. It is the goal that this effort will to lead to an RFP for vehicles.

<sup>9</sup> <https://u2c.jtafla.com/media/2202/i-20-002-ultimate-urban-circulator-u2c-program.pdf>

<sup>10</sup> <https://www.transit.dot.gov/research-innovation/strategic-transit-automation-research-plan-report-0116>

<sup>11</sup> [https://www.its.dot.gov/research\\_areas/attri/index.htm](https://www.its.dot.gov/research_areas/attri/index.htm)

<sup>12</sup> <https://www.apta.com/research-technical-resources/standards/procurement/>

<sup>13</sup> [https://www.apta.com/wp-content/uploads/Policy-Brief\\_AVFinal.pdf](https://www.apta.com/wp-content/uploads/Policy-Brief_AVFinal.pdf)

## Appendix A

### Next Generation, Purpose-Built, Transit Automated Vehicle

Vehicle Category	Key Performance and Design Parameters (KPPs)	Description	Objective/Target	Tolerance	Mandatory
<b>Key Baseline Vehicle Requirements</b>	Automation Level	Vehicle shall be automated and meet SAE J3016 vehicle driving automation standards.	Level 4	+/-1	Yes
	Local Content Requirements	Vehicle shall be Buy America transit compliant and meet the minimum local content requirement; necessary for federal funding activities ( <a href="https://www.transit.dot.gov/regulations-and-guidance/buy-america-compliance-review">https://www.transit.dot.gov/regulations-and-guidance/buy-america-compliance-review</a> ).	70%	N/A	Yes <sup>1</sup>
	Americans with Disabilities Act (ADA)	Vehicle shall be ADA Transit compliant to allow for accommodations of all passengers; assuming safety operator on board ( <a href="https://www.transit.dot.gov/regulations-and-guidance/civil-rights-ada/ada-regulations">https://www.transit.dot.gov/regulations-and-guidance/civil-rights-ada/ada-regulations</a> ).	N/A	N/A	Yes
	Vehicle Testing	Vehicle shall pass any mandated, if any, AV vehicle testing requirements like Altoona for transit buses.	N/A	N/A	Yes <sup>1</sup>
	Vehicle Safety	Vehicle shall meet all National Highway Safety Transportation Administration (NHSTA) and Federal Motor Vehicle Safety Standards (FMVSS) requirements ( <a href="https://www.transit.dot.gov/funding/procurement/third-party-procurement/federal-motor-vehicle-safety-standards">https://www.transit.dot.gov/funding/procurement/third-party-procurement/federal-motor-vehicle-safety-standards</a> ).	N/A	N/A	Yes
	Propulsion	Vehicle shall be propelled by a zero emissions powertrain source (i.e. Battery Electric, Hydrogen, other).	N/A	N/A	Yes
	Wheelchair Accessibility	Vehicle shall be able to accommodate wheelchair bound passengers and do so with use of an automatic ramp that provides access for loading and unloading where activation is accessible by the wheelchair bound passenger or on board safety operator.	N/A	N/A	Yes
	Vehicle Daily Operations - Time	Vehicle shall be capable of operating over a required minimal timeframe/day under all conditions and demands for heating and cooling; following standard operating procedures (e.g. charging, in route charging).	9 Hours	+/- 1	Yes
	Vehicle Daily Operations - Distance	Vehicle shall be capable of operating over a required minimal distance/day with maximum loads and demands for heating and cooling following standard operating procedures (e.g. charging, in route charging).	180 Miles	NA	Yes
	Vehicle Useful Life	Vehicle shall meet federal vehicle useful life expectancy and have considerations for upgradable software and/or over the air (OTA) updates to ensure extended life with current and innovative features.	6.5 Years	+/- 1.5	Yes

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Vehicle Category	Key Performance and Design Parameters (KPPs)	Description	Objective/Target	Tolerance	Mandatory
Beyond ADA Accessibility - Human Machine Interfaces (HMI)	Wheelchair Restraints	Vehicle should have access to automated wheelchair restraint system.	N/A	N/A	Yes <sup>2</sup>
	Bi-Directional Voice Assistance	Vehicle shall have a bidirectional voice assistance system so that passengers and/or operators can communicate outwardly to a control center.	N/A	N/A	Yes <sup>2</sup>
	Languages	System must accommodate multiple languages including but not limited to English, Spanish, Chinese.			Yes <sup>2</sup>
	Blind Passengers	System must accommodate communication needs of blind passengers (i.e. available seat locations, location status and stop/exit support).			Yes <sup>2</sup>
	Deaf Passengers	System must accommodate communication needs of deaf passengers (i.e. location status stop/exit support, and ramp deployment concerns).			Yes <sup>2</sup>
	Communication Systems (Interior)	Vehicle shall have considerations for directed lighting, voice and sound communications to alert and communicate with passengers (i.e. route status, emergency direction, location, ETA, etc.). Passengers must also have access to communicate emergency situations on a real-time basis.	N/A	N/A	Yes <sup>2</sup>
	Languages	System must accommodate multiple languages including but not limited to English, Spanish, Chinese.			Yes <sup>2</sup>
	Blind Passengers	System must accommodate communication needs of blind passengers (i.e. recognition of vehicle approaching, available seat locations, location status, stop/exit support, and ramp deployment status).			Yes <sup>2</sup>
	Deaf Passengers	System must accommodate communication needs of deaf passengers (i.e. location status and stop/exit support).			Yes <sup>2</sup>
	Communication Systems (Exterior)	Vehicle shall have considerations for guidance systems, right of way, door opening/closing at pick up and drop off locations.	N/A	N/A	Yes <sup>2</sup>
	Languages	System must accommodate multiple languages including but not limited to English, Spanish, Chinese.			Yes <sup>2</sup>
	Blind Passengers	System must accommodate communication needs of blind passengers (i.e. available seat locations, location status stop/exit support, and ramp deployment status).			Yes <sup>2</sup>
	Deaf Passengers	System must accommodate communication needs of deaf passengers (i.e. location status and stop/exit support).			Yes <sup>2</sup>
	Video System	Vehicle shall have consideration for in-cabin video analytics and bidirectional communication for remote customer service to provide support in the case of an emergency situation including but not limited to an injured passenger, ill passenger, unruly/unwanted passenger, illicit drug use, smoking, etc.).	N/A	N/A	No

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Vehicle Category	Key Performance and Design Parameters (KPPs)	Description	Objective/Target	Tolerance	Mandatory
Operational Design Domains (ODDs)	Operational Infrastructure	Vehicle shall operate under a variety of infrastructure conditions; dedicated lane/path and mixed use traffic while recognizing and adjusting to the availability and placement of operational surfacing, navigation aids (e.g., beacons, lane markings, augmented signage), traffic management devices (e.g., traffic lights, right of way signage, vehicle running lights), keep-out zones, special road use rules (e.g., time-dependent lane direction changes) and vehicle-to-infrastructure availability.	N/A	N/A	Yes
	Operational Terrain	Vehicle shall operate across location dependent characteristics (e.g., slope, camber, curvature, banking, coefficient of friction, road roughness, air density) including immediate vehicle surroundings and projected vehicle path.	N/A	N/A	Yes
	Vehicle Handling (Slope)	Vehicle shall be able to traverse slopes with full passenger loads without opportunity to harm or injure passengers.	+/-12 Degrees		Yes <sup>3</sup>
	Operational Service/Use Cases	Vehicle shall be able to operate in one or more, but are not limited, of the following types of services/location, to downtown, campus, community circulator, paratransit, on-demand, geofenced urban network, commuter lot shuttle, first/last mile, fixed stopped, micro transit or multimodal.	N/A	N/A	Yes
	Environmental Communications	Vehicle shall meet and interact with the environment and other aspects of the operational state space, including traffic laws, social norms, and customary signaling and negotiation procedures.	N/A	N/A	Yes
	Environment/Weather Conditions	Vehicle shall operate under various but defined surface temperature, air temperature, wind, visibility, precipitation, icing, lighting, glare, electromagnetic interference, clutter, vibration, and other types of sensor noise conditions.	N/A	N/A	Yes
	Regional Operation	Vehicle shall meet US safety requirements and recognize standard safety equipment (i.e. stop signs, one-way and directional signage).	N/A	N/A	Yes
	Communications	Vehicle must support communication modes, bandwidth, latency, stability, availability, reliability, including both machine-to-machine communications and human interaction.	N/A	N/A	Yes
	Temporary Operational Conditions	Vehicle shall be able to operate under temporary changes in the operating environment (e.g., construction zones, traffic jams, temporary traffic rules such as for hurricane evacuation).	N/A	N/A	Yes

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Vehicle Category	Key Performance and Design Parameters (KPPs)	Description	Objective/Target	Tolerance	Mandatory
General Vehicle Design	Vehicle Length	Vehicle length shall be set to meet maximum passenger capacity requirement.	N/A	N/A	Yes
	Vehicle Width	Vehicle width shall be set to meet the maximum passenger capacity requirement.	7 Feet*	+/- 1	No
	Vehicle Height	Vehicle height shall be set to meet the maximum passenger capacity requirement.	7.5 Feet*	+/- 1.5	No
	Passenger Capacity (Seated)	Vehicle shall be designed to accommodate a number of passengers seated.	12 Persons	+/-2	Yes
	Passenger Capacity (Standing)	Vehicle shall be designed to accommodate a number of passengers standing.	N/A	N/A	No
	Wheelchair Capacity	Vehicle shall accommodate additional capacity for wheelchairs to be secured.	1 Wheelchair	+1	Yes
	Safety Operator	Vehicle shall have a dedicated location for the vehicle's safety operator to ensure their safety during early development deployments and until cleared by the Federal government to remove.	1 Location	N/A	Yes
	Interior Layout	Vehicle shall have an interior layout that accommodates the minimum passenger/wheelchair/operator requirement.	N/A	N/A	Yes
	Visual Aids	Vehicle should provide the ability for passengers to have a 360 view of the environment (i.e. mirrors, video feed) surrounding the vehicle to aid in passenger comfort.	N/A	N/A	No
	Turning Radius	Vehicle shall have a turning radius similar to a standard passenger SUV.	39 Feet	+/- 3	Yes
	Vehicle Speed (Low Speed Operations)	Vehicle shall operate up to and maintain the required speed defined.	25 MPH	+/- 5	Yes
	Vehicle Speed (High Speed Operations)	Vehicle should have the capability to accelerate to and maintain the required speeds.	55 MPH	+/- 5	No
	Vehicle Access Entrance/Exit	Vehicle shall meet to the applicable laws for entrance/exit requirements and ensure emergency exits are available and accessible to passengers.	N/A	N/A	Yes
	Steering System	Vehicle shall have an available steering system (i.e. steering wheel) to allow for an operator to take control over the vehicle when the appropriate situation calls for assistance (e.g. temporary emergency situation).	N/A	N/A	Yes <sup>4</sup>
	Seating Restraints	Vehicle shall have a safety seat restraint for each seated passenger (i.e. seat belt).	1/Seat	N/A	No
	Restraint System Status	Vehicle should recognize the vehicle system restraint status and determine go/no-go decisions based off of status.	N/A	N/A	No
Heating/Cooling	Vehicle must have a heating and cooling system that adjusts automatically to the outside ambient temperature to ensure passenger comfort throughout the entire interior (Temp and Humidity).	N/A	N/A	Yes	

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Vehicle Category	Key Performance and Design Parameters (KPPs)	Description	Objective/Target	Tolerance	Mandatory
Charging and Energy Systems	Vehicle Charging	Vehicle shall be capable of being charged using an industry standard level 2/3 connector (i.e. CHAdeMo, J1772) to ensure continuous operations up to the minimum requirement, if powered by battery electric systems and include considerations for electric charging for vehicles including opportunity charging, inductive charging, or plug-in.	N/A	N/A	Yes
	Battery Management System	Vehicle shall have a battery management system that will actively monitor and control systems as to meet vehicle range requirements and ensure uninterrupted operations and passenger comfort at all times.	N/A	N/A	Yes
Fueling System	Non-Battery Electric Fueling	Vehicle should have considerations for zero emission gaseous based fueling, in the case of non battery electric propulsion system (i.e. hydrogen, other).	N/A	N/A	No
Vehicle E/E Systems	Vehicle Communication Platform	Vehicle shall have considerations for connected vehicle strategies (V2V, V2I, V2P, V2X) utilizing 4G, 5G and/or DSRC allowing for real time communications (i.e. traffic, road conditions, unplanned route issues) A66.	25Mb/sec upload	N/A	Yes
	Object Detection	Vehicle shall have a refined object detection enabling operating speeds of 25 MPH (+/- 5) within $\pm$ X foot of stationary objects and within +/- Y feet of moving objects.	a.) Within X Foot (stationary objects) b.) Within Y Feet (moving objects)	a.) +/-XX b.) +/- YY	Yes <sup>5</sup>
	Real-time Software Updates	Vehicle software shall be able to be updated over the air (OTA) software updates.	N/A	N/A	Yes
	Vehicle Sensors	Vehicle shall have a software/sensor stack which could include Lidar, cameras, GPS, ultrasonic, radar, etc.	N/A	N/A	Yes
	Remote Operations	Vehicle shall have the ability for remote control outside the vehicle from a depot or other main control center should the need arise (e.g. Unavailable safety operator, conditions requiring external assistance).	N/A	N/A	Yes
	Cybersecurity	Considerations need to be made for cybersecurity including the projection of personally identifiable information (PII).	N/A	N/A	Yes

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Vehicle Category	Key Performance and Design Parameters (KPPs)	Description	Objective/Target	Tolerance	Mandatory
Enabling Technologies	Passenger Counting	Vehicle system shall have the ability to report ridership numbers.	N/A	N/A	Yes <sup>2</sup>
	Passenger Capacity and Status Communication	Vehicle should have the ability to understand and communicate real-time seating capacity using maximum capacity requirements for traveler trip planning.	N/A	N/A	No
	Fleet Management	Vehicle shall have considerations for automated vehicle location and fleet management applications and/or system integration allowing for real time location and operational maintenance status.	N/A	N/A	Yes <sup>2</sup>
	Fare Payment	Vehicle should have considerations for fare payment strategies and/or system integration including cash payments, accommodating unbanked riders, or customers with no access to mobile phones.	N/A	N/A	Yes <sup>2</sup>
	Remote Customer Service	Vehicle shall have consideration for in-cabin video analytics and bidirectional communication and/or system integration for remote customer service to provide support in the case of an emergency situation including but not limited to an injured or ill passenger.	N/A	N/A	Yes <sup>2</sup>
	WiFi Access	Vehicle shall have wireless internet access capability.	25Mb/sec upload	N/A	Yes
Operation & Procurement Considerations	Turnkey Operations	The vehicle product should support transit agency procurement methods and desire for complete operations to allow for transits to build, operate, manage, and maintain.	N/A	N/A	Yes
	Risk Mitigation	Standard operating procedures for safety elements should be made available.	N/A	N/A	Yes
	Reliability	Maintenance and service schedule shall be available to the end user.	N/A	N/A	Yes
	Purchase/Lease Options	Purchase and lease options shall be available for the purchaser to choose from.	N/A	N/A	Yes
Miscellaneous	Training Materials	Training materials for all vehicle and operational aspects including operational checklists, route programming and rerouting, and maintenance requirements.	N/A	N/A	Yes
	Component Identification	Vehicle systems/components need to be designed so that they can be visually identified by maintenance personnel (i.e. labels, color coding).	N/A	N/A	Yes
	Safety and Testing	Documented Safety Certification and Testing Regimen.	N/A	N/A	Yes
	Vehicle and System Data	Available vehicle and system data will be communicated by OEM.	N/A	N/A	Yes
	Data Handling	Standard/Agreed upon vehicle and system data should be held secure and retained for a minimum period. Data collection duration should follow standard industry practices.	N/A	N/A	Yes
	Materials	Materials used for the vehicle, especially interior, must not be porous to aid in cleaning and sterilization of the vehicle.	N/A	N/A	Yes
	Sterilization	Accommodations for vehicle sterilization should be considered to ensure the public's health and safety in the event of a pandemic.	N/A	N/A	No

<sup>1</sup> If federal funding will be used for acquisition of vehicles

<sup>2</sup> A mandatory optional feature at the point of purchase

<sup>3</sup> Meet needs of various geographical locations (i.e. San Francisco)

<sup>4</sup> Design to be based on current federal/state level requirements (i.e. California)

<sup>5</sup> OEM to determine and report X and Y capabilities and tolerances XX and YY

\* Size requirement for Jacksonville Transit Authority's Ultimate Urban Circulator

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