Statement of Work / Project Management Plan

Project Name:
Demonstration of Collision Avoidance and Mitigation Technologies on Los Angeles Metro Bus Service

FTA TrAMS Number:
CA-2017-055-00

Recipient:
Los Angeles County Metropolitan Transportation Authority

Funding Agency:
Federal Transit Administration

Date Submitted: April 21, 2017

Summary Page

Project Title:	Demonstration of Collision Avoidance and Mitigation Technologies on Los Angeles Metro Bus Service
FTA TrAMS Number:	CA-2017-055-00
Performing Agency:	Los Angeles County Metropolitan Transportation Authority
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Performance Period:	July 1, 2017 – June 30, 2020
Funding Amount:	$1,450,000 (Federal Amount) $550,000 (Cost Share)

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1.0 PROJECT SCOPE

Background: Collisions are costly concern across transit properties. APTA has posted a document "Application of Automated Driving Technology to Bus Transit-Functional Capabilities for Safety and Capacity" detailing the costs associated with collisions. According to the report, bus transit properties reported 3,260 collisions in 2011. The result was almost 13,000 injuries, 92 fatalities, and casualty and liability expenses exceeding $480 million dollars. The report estimates the average cost per bus is more than $8,000. The statistics are even more unsettling when considering the 10-year period from 2001-2011. During that period, the bus transit industry reported nearly 900 fatalities, more than 134,000 injuries, and casualty and liability expenses in excess of $4 billion dollars.

Goal: Los Angeles County Metropolitan Transportation Authority (Metro), New Flyer Industries Inc. (New Flyer), and the Center for Transportation and the Environment (CTE) are partnering to demonstrate and evaluate collision avoidance and mitigation technology for transit buses operating in the urban environment. The objective of the project is to evaluate the current "state of the art" of commercial collision avoidance and mitigation systems and to assess the ability of such a system to reduce the number of vehicle, pedestrian, and cyclist collisions during transit bus service in a large urbanized area.

Approach: The team will evaluate commercially available collision avoidance and mitigation systems from multiple vendors and select up to two systems for demonstration. Selected systems will be installed on Metro buses and demonstrated in urban-area revenue service for 18-months. During the demonstration, collision and collision avoidance data shall be collected and reviewed to assess the effectiveness of the technology.

By having the commitment of Metro and New Flyer, the project is uniquely positioned to capture feedback from industry leaders in both the transit agency and transit vehicle manufacturer sectors. Buy-in from both of these parties is critical for the technology to be accepted and ultimately deployed in widespread revenue-service applications. Metro's urban operating environment presents unique challenges and will serve as an ideal proving ground for collision avoidance technology, which has traditionally been most well suited for rural and/or highway driving applications. New Flyer's commitment to the project will be vital to understanding the commercial readiness level of the systems, providing a path forward for commercialization. The goals of the project align with New Flyer's own safety initiatives, and New Flyer's ultimate desire is to offer the technology as integrated original equipment, as opposed to an after-market add-on feature. In addition to Metro and New Flyer, the project benefits from having CTE, an independent, non-profit organization experienced with federally funded transportation pilot projects, acting as a project manager and data collection agent.

2.0 PROJECT DESCRIPTION

Problem Statement: The benefits, costs, and capabilities of collision avoidance and mitigation technology for transit buses in an urban operating environment are not fully understood by the transit industry at this time.

History/Current Design: The development of advanced computers, sensors, and communication systems have allowed technology providers to create advanced collision avoidance and mitigation systems, such as blind spot warning, pedestrian collision warning, driver alert warning, and automatic braking. Such technologies are becoming more popular in the light-duty personal vehicle market; however, widespread adoption of these technologies has yet to occur in the transit industry. In addition, many of the available technologies are optimized for highway speeds and their effectiveness in an urban setting has not been evaluated. Five commercially available technologies are described below:

Bendix® Wingman® Fusion™ – This system integrates camera, radar and brake systems for advanced commercial vehicle driver assistance. The Mobileye System-on-Chip EyeQ processor with state-of-the-art-vision algorithms powers the camera. The radar, camera, and brake system are linked to each other – constantly gathering, sharing, and confirming information; and all the while communicating with the brakes.

OnGuardACTIVE™ (Meritor WABCO) – This system is a radar-based active safety system that offers Collision Mitigation and Adaptive Cruise Control (ACC). OnGuardACTIVE detects moving, stopped or stationary vehicles ahead and measures the vehicle's position in relation to others on the road to warn the driver of possible rear-end collision by providing audible, visual and haptic warnings. When appropriate, the system will apply the brakes to help avoid or mitigate an unavoidable collision.

Protran Technology – Protran Technology Safe Turn Alert (STA) System is a standalone, passive audible warning system designed to play an audible warning message external and/or internal to the vehicle when the vehicle is making a right or left hand turn. The system also has the option for flashing LED strobe lights that act as a visual warning to pedestrians as the vehicle is turning. There are two options for triggering the STA system; proximity sensors mounted near the pitman arm or the system can be triggered with the vehicles blinker.

Mobileye Shield+^{TM} – This Mobileye system is the most advanced collision avoidance system available on the market for trucks, buses, and commercials vehicles; it can be retrofitted to any vehicle. The system includes strategically placed multi-vision smart cameras and interior display modules that alert the driver both visually and audibly if a pedestrian or cyclist is in the driver's blind spot. It is designed to only alerts drivers if a collision is imminent with vulnerable road users, not inanimate objects. In addition, this solution includes a full telematics system which tracks the vehicle and reports all warnings made by the Mobileye System to your fleet management system, providing fleet managers with valuable information about their drivers' daily driving behavior.

The Mobileye Shield+ package includes the following lifesaving features:

- Pedestrian and Cyclist Collision Warning (Mobileye PCW)
- Forward Collision Warning (Mobileye FCW)
- Headway Monitoring Warning (Mobileye HMW)
- Lane Departure Warning (Mobileye LDW)

- Speed Limit Indicator (SLI)

Autoliv – Autoliv develops Active Safety systems with radar and vision technologies to make driving easier and safer by monitoring the environment around the vehicle, giving our active safety systems a chance to adjust engine output, steering or braking to avoid a crash. Utilizing advanced radar and vision technology, Autoliv's aim is to provide:

- Early warnings to drivers, so they can take appropriate action
- Intelligent systems that affect the vehicle's motion using braking and steering, helping the driver avoid the hazard
- Improved restraint systems that combine hazard information with traditional crash sensing methods, in case a collision is unavoidable.

Automotive radar devices are now appearing in passenger vehicles all over the world. These devices are used in advanced cruise control systems, which can direct a vehicle's accelerator and braking systems, controlling the distance between it and another vehicle.

The radar sensors note vital information, such as range, angle and Doppler velocity. This information is used to determine the driving situation and warn the driver in potentially dangerous events. If the driver does not take appropriate action in time and a crash is about to happen, advanced radar systems can take control of the vehicle to avoid the crash or lessen the accident's severity. This high level of safety functionality is maintained in bad weather and no light, when driving conditions are at their worst.

Objectives: The project will evaluate advanced collision avoidance and mitigation systems from multiple technology providers and select one or two systems for deployment and demonstration in an urban transit-operating environment. Through the demonstration, the team will be able to assess the technology's effectiveness in an urban setting with both motorized and non-motorized (pedestrians and bicyclists) traffic. The team will compare results from the demonstration against data on buses in the fleet operating without any collision avoidance technology, as well as buses currently equipped with a right-turn detection product from Protran.

Objective 1: Define system requirements and select technology for demonstration.

The team will establish constraints and criteria for the collision avoidance and mitigation system, evaluate systems offered by five different vendors (Mobileye, Bendix, Wabco, Autoliv, and Protran), and select up to two systems for demonstration in Metro's fleet.

Objective 2: Develop integration plan, and install and test prototype system(s).

The team will complete an engineering analysis (e.g. FMEA), develop a vehicle installation plan, and perform closed track performance testing and validation in preparation for deployment.

Objective 3: Install system(s) on New Flyer buses within the Metro fleet and demonstrate technologies in revenue service.

The selected system(s) will each be installed on up to 20 buses within Metro's fleet and demonstrated in revenue-service for 18 months. The demonstration sample includes up to 60 buses outfitted with collision avoidance and mitigation technology and will be constructed as follows:

Collision Avoidance and Mitigation System	**# of Buses Deployed with System up to**
1. new technology	20
2. new technology or existing Protran system with added left-turn detection	20
3. existing Protran system with right-turn detection only	20
4. no system	20

Objective 4: Define performance metrics and collect and review demonstration data.

Collision and collision avoidance data will be collected and stakeholder surveys (operator, passenger, and maintenance personnel) will be conducted throughout the demonstration period. The intent is to collect data in such a manner that results can be compared against a control group (up to 20 buses in the fleet operating without collision avoidance technology). Specific technology performance metrics will be finalized prior to the demonstration and data collection activities, which are scheduled to begin in Project Quarter 6 (Quarter 4 of 2018). A draft of the performance metrics is included in Section 9 of this Statement of Work. Tracking the performance metrics throughout the demonstration will allow the team to gauge the effectiveness and ROI of the technology.

Objective 5: Ensure the program meets all project objectives by effectively managing project scope, budget, work plan, and schedule.

Project management and administration activities are required to ensure the project meets its objectives. The project team will conduct regular conference calls (weekly or biweekly) to review project progress, risks, issues, mitigation strategies, and action items.

3.0 DETAILED PROJECT OBJECTIVES / TASKS

Objective 1: Define system requirements and select technology for demonstration.

Task 1.1 – Define Technology Requirements and Criteria
Develop requirements and criteria for integrating collision avoidance and mitigation systems within New Flyer buses in the Metro fleet. At minimum, these requirements and criteria shall include technical installation requirements (mechanical mounting, electrical interface, and communication protocol), vendor experience with same or similar applications, and commercialization potential.

Task 1.2 – Evaluate State of Art against Requirements & Criteria
Assess the ability of available collision avoidance and mitigation systems from several different vendors to meet the technology requirements and criteria. This includes product literature reviews and discussions with vendors.

Some technology providers claim to have the ability to communicate with the bus brake controller and automatically actuate the braking system without operator input. This feature will be evaluated during this phase of the project.

Task 1.3 – Select Technology for Demonstration
Select at least one and up to two collision avoidance and mitigation systems to demonstrate on New Flyer buses in the Metro fleet. System's will be selected based on their technical installation requirements (mechanical mounting, electrical interface, and communication protocol), vendor experience with same or similar applications, commercialization potential, and any other constraints or criteria that project stakeholders identify during Task 1.1.

LA Metro currently operates buses with a Protran collision avoidance system with right-turn detection capabilities. Should a new system besides Protran be selected for this project demonstration, then left turn detection capabilities will be added to the existing Protran system and this will be considered as a second technology for evaluation during the demonstration period.

Task 1.4 – Provide major documents to FTA Program Manager.
Provide major documents (non-proprietary) that show completed plans, designs, analysis, and surveys at the end of Objective 1 to FTA Program Manager.

Task 1 Deliverables/Milestones: Requirements/Criteria Document; Technology selection

Objective 2: Develop integration plan, and install and test prototype system(s).

Task 2.1 – Develop Integration Plan
Review the mechanical and electrical integration requirements of the collision avoidance and mitigation system(s), including control architecture and diagnostics. Complete the following engineering and system development work:

Mechanical Systems:
- define component layout
- complete component mounting design (bracket definition, FEA, drawings and engineering release)
- define modifications to cascading systems

Electrical Systems:
- develop theory of operation
- complete controls programming and bus integration plan, including diagnostics

- define check-out procedures

Task 2.2 – Procure Prototype Components
Order and receive collision avoidance and mitigation system(s) and other integration material (e.g. mounting brackets and wiring) for prototype testing and validation.

Task 2.3 – Install and Test Prototype System (closed track evaluation)
New Flyer will install one prototype for each of the system(s) selected in Task 1.3 for demonstration on Metro bus(es) at the New Flyer facility for test and validation. This includes a functional test of the prototype bus systems and a simulation of in-service functionality on a closed track. Design refinement may occur based on test results.

If the selected system(s) include a brake assistance feature, then New Flyer will integrate the feature with the prototype and assess the feasibility of deploying brake assistance in the real world. Ultimately, the decision to deploy a system that includes brake assistance into revenue service will be the decision of the entire team. Things unrelated to the technology, such as labor union rules, may impact the decision to utilize brake assistance.

Task 2.4 – Provide major documents to FTA Program Manager.
Provide major documents (non-proprietary) that show completed plans, designs, analysis, and surveys at the end of Objective 2 to FTA Program Manager.

Task 2 Deliverables/Milestones: Evidence of Prototype Procurement and Installation on Test bus(es); Prototype Test Report.

Objective 3: Install system(s) on New Flyer buses within the Metro fleet and demonstrate technologies in revenue service. Metro and its partners shall make sure that these experimental buses shall operate in an environment with similar operating conditions to that of the control buses to ensure like comparison.

Task 3.1 – Develop Detailed Deployment Plan
Metro will research bus routes that accumulated higher than average road collision incidents in its service area. Metro will look at these routes and note whether or not they crisscross downtown Los Angeles where a confluence of traffic by pedestrians, bicycles, motorcycles, automobiles, trucks/vans, and buses will be ideal for the demonstration of collision avoidance and mitigation technologies. Metro will also find out the number of buses that are needed to support these bus routes for all-day base runs or during peak service hours. The needs for operational flexibility and the constraints set by locking the 80 test buses on a single bus route for 18 months will be examined to determine if this approach is feasible. Another approach will be to assign the 80 test buses to a Bus Operations Division where they may be assigned daily at random to any bus route served by that Division.

Task 3.2 – System Installation
After prototype test and validation, the collision avoidance and mitigation system(s) will be installed on Metro buses. Each elected system will be installed on up to 20 buses.

Task 3.3 – Conduct Driver and Maintenance Training
The technology provider and New Flyer shall institute a training program for Operations Central Instruction (OCI) instructors so they may teach the operators at the Divisions on how to operate and react when driving a bus with a new technology.

The technology provider and NF shall conduct training for Maintenance Instruction so they may teach the mechanics at the Divisions on how to troubleshoot and repair a new technology.

Task 3.4 – Demonstrate Technology in Revenue Service
Buses equipped with the collision avoidance and mitigation technology will be deployed in revenue service for 18 months. Up to twenty (20) buses without the technology will be monitored as a control group.

The technology provider and New Flyer will stand ready to assist Metro with diagnosing and repairing an unresolved issue related to a new technology during the demonstration.

Metro will work with the Division management to ensure the 80 test buses are properly assigned and concurrently running.

Task 3.5 – System Disposition
At the end of the technology demonstration, the technology provider and New Flyer will remove the test technology and restore all test buses to their original bus configuration.

Task 3.6 – Provide major documents to FTA Program Manager.
Provide major documents (non-proprietary) that show completed plans, designs, analysis, and surveys at the end of Objective 3 to FTA Program Manager.

Task 3 Deliverables/Milestones: Detailed Deployment Plan; Evidence of System Procurement and Installation; Training Logs.

Objective 4: Define performance metrics and collect and review demonstration data.

Task 4.1 – Confirm Key Collision Metrics & Data Collection Procedure
CTE shall receive instructions on how to access Metro TransitSafe archive, how to collect collision data, and how to follow up on a collision report for the 80 test buses monitored during the demonstration.

TransitSafe is a safety database maintained by Metro Corporate Safety that categorizes safety data by incident date/time, driver name/badge number, bus type, route number, operating division, location of the incident, any injury or fatality, and statements made by the bus operator recounting the incident. These initial performance metrics, and other key performance indicators (KPIs), are shown in the Appendix. During this task, the team will identify any additional performance metrics that need to be tracked and finalize the data collection and reporting procedure.

Task 4.2 – Collect Baseline Data (experimental control)
CTE will collect daily operations and incident data on the 20 buses in the control group (buses without a collision avoidance and mitigation technology).

Task 4.3 – Collect Collision and Collision Avoidance Data
CTE will collect daily operations and incident data on the buses equipped with the experimental collision avoidance and mitigation system(s). CTE will also document the cost of the system(s) in order to conduct an ROI.

Task 4.4 – Collect Personnel Survey Data
CTE will develop and conduct surveys for Metro drivers, maintenance personnel, and passengers to help gauge strengths and weaknesses of the system(s).

Task 4.5 – Summarize and Report Data (Data Evaluation)
Data will be summarized and shared with project stakeholders every 6-months of the demonstration activity.

Task 4.6 – Provide major documents to FTA Program Manager.
Provide major documents (non-proprietary) that show completed plans, designs, analysis, and surveys at the end of Objective 4 to FTA Program Manager.

Task 4 Deliverables/Milestones: Final Description of Performance Metrics and Data Collection Procedure; 6-Month Demonstration Data Summary; 12-Month Demonstration Data Summary; 18-Month Demonstration Data Summary.

Objective 5: Ensure the program meets all project objectives by effectively managing project scope, budget, work plan, and schedule.

Task 5.1 – Draft and Execute Contract and Subcontracts
Metro will contract with FTA and execute subcontracts with New Flyer and CTE.

Task 5.2 – Conduct Project Kickoff
CTE conducts a Project Kickoff Meeting to review the project scope, schedule, and budget with stakeholders, including FTA, before beginning project activity.

Task 5.3 – Conduct Weekly Project Status Meetings
Throughout the project, the team will conduct regular conference calls (week or bi-weekly) to discuss project progress, risks, issues, mitigation strategies, and next steps. FTA Program Manager will be invited to attend.

Task 5.4 – Track Action Items and Monitor Project Budget/Schedule
CTE will track technical action items and support Metro's efforts to manage the project budget and schedule.

Task 5.5 – Draft and Distribute Quarterly Reports

CTE will document project progress in a quarterly report and share the progress reports with team members, including FTA Program Manager.

Task 5.6 – Draft and Submit Final Report
CTE will summarize project findings in a detailed report, including lessons learned and best practices for selecting and implementing collision avoidance and mitigation technologies for the urban transit application. Refer sections 6, 7 and 8.

Task 5.7 – Maintain FTA TrAMS Account
Metro will maintain the project account in FTA TrAMS. This includes posting QPRs, FFRs and MPRs. The project team will support this activity and provide information, as needed.

Task 5 Deliverables/Milestones: Project Kickoff meeting; FTA Deliverables (per Section 6);

Figure 1 shows what team member is responsible for ensuring each specific task is completed.

Objective / Task Title and Description		Organization with Lead Responsibility	Location
Objective 1 - Define system requirements and select technology for demonstration.			
1.1	Define Technology Requirements and Criteria	New Flyer	-
1.2	Evaluate State of Art against Requirements & Criteria	New Flyer	-
1.3	Select Technology for Demonstration	Team Decision	-
1.4	Provide Major Documents to FTA Program Manager	CTE	electronic
Objective 2 - Develop integration plan, and install and test prototype system(s).			
2.1	Develop Integration Plan	New Flyer	St. Cloud, MN
2.2	Procure Prototype Components	New Flyer	St. Cloud, MN
2.3	Install and Test System (closed track evaluation)	New Flyer	St. Cloud, MN
2.4	Provide Major Documents to FTA Program Manager	CTE	electronic
Objective 3 - Install system(s) on New Flyer buses within the Metro fleet and demonstrate in revenue service.			
3.1	Develop Detailed Deployment Plan	LA Metro	Los Angeles, CA
3.2	System Installation	New Flyer	Ontario, CA
3.3	Conduct Driver and Maintenance Training	LA Metro / New Flyer*	Los Angeles, CA
3.4	Demonstrate Technology in Revenue Service	LA Metro	Los Angeles, CA
3.5	System Disposition	New Flyer	Ontario, CA
3.6	Provide Major Documents to FTA Program Manager	CTE	electronic
Objective 4 - Define performance metrics and collect and review demonstration data.			
4.1	Confirm Key Collision Metrics & Data Collection Procedure	CTE	-
4.2	Collect Baseline Data (experimental control)	CTE	Los Angeles, CA
4.3	Collect Collision and Collision Avoidance Data	CTE	Los Angeles, CA
4.4	Collect Personnel Survey Data	CTE	Los Angeles, CA
4.5	Summarize and Report Data (Data Evaluation)	CTE	-
4.6	Provide Major Documents to FTA Program Manager	CTE	electronic
Objective 5 - Manage project activity and provide general oversight to ensure the program meets objectives.			
5.1	Draft and Execute Contracts/Subcontracts	LA Metro	electronic
5.2	Conduct Project Kickoff	CTE	Los Angeles, CA
5.3	Conduct Weekly Project Status Meetings	CTE	teleconference
5.4	Track Action Items and Monitor Project Budget/Schedule	CTE	electronic
5.5	Draft and Distribute Quarterly Reports	CTE	electronic
5.6	Draft and Submit Final Report	CTE	electronic
5.7	Maintain FTA TrAMS Account	LA Metro	electronic

* New Flyer will train LA Metro instructors, and LA Metro instructors will coordinate and conduct training classes with drivers and maintenance personnel. The technology provider(s) will be expected to support training activities.

Figure 1. Team Member Roles and Responsibilities

4.0 WORK SCHEDULE / MILESTONES

Figure 2 shows expected durations and completion dates for project tasks.

Objective / Task Title and Description		2017		2018				2019				2020	
		Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Objective 1 - Define system requirements and select technology for demonstration.													
1.1	Define Technology Requirements and Criteria		■										
1.2	Evaluate State of Art against Requirements & Criteria		■										
1.3	Select Technology for Demonstration		■										
1.4	Provide Major Documents to FTA Program Manager		■										
Objective 2 - Develop integration plan, and install and test prototype system(s).													
2.1	Develop Integration Plan		■	■									
2.2	Procure Prototype Components		■	■									
2.3	Install and Test System (closed track evaluation)			■	■								
2.4	Provide Major Documents to FTA Program Manager				■								
Objective 3 - Install system(s) on New Flyer buses within the Metro fleet and demonstrate technologies in revenue service.													
3.1	Develop Detailed Deployment Plan					■							
3.2	System Installation					■							
3.3	Conduct Driver and Maintenance Training					■							
3.4	Demonstrate Technology in Revenue Service						■	■	■	■	■	■	
3.5	System Disposition												■
3.6	Provide Major Documents to FTA Program Manager												■
Objective 4 - Define performance metrics and collect and review demonstration data.													
4.1	Confirm Key Collision Metrics & Data Collection Procedure					■							
4.2	Collect Baseline Data (experimental control)					■	■	■	■	■	■	■	
4.3	Collect Collision and Collision Avoidance Data						■	■	■	■	■	■	
4.4	Collect Personnel Survey Data						■	■	■	■	■	■	
4.5	Summarize and Report Data (Data Evaluation)						■	■	■	■	■	■	■
4.6	Provide Major Documents to FTA Program Manager												■
Objective 5 - Manage project activity and provide general oversight to ensure the program meets all project objectives.													
5.1	Draft and Execute Contracts/Subcontracts	■											
5.2	Conduct Project Kickoff	■											
5.3	Conduct Weekly Project Status Meetings	■	■	■	■	■	■	■	■	■	■	■	■
5.4	Track Action Items and Monitor Project Budget/Schedule	■	■	■	■	■	■	■	■	■	■	■	■
5.5	Draft and Distribute Quarterly Reports	■	■	■	■	■	■	■	■	■	■	■	■
5.6	Draft and Submit Final Report												■
5.7	Maintain FTA TrAMS Account	■	■	■	■	■	■	■	■	■	■	■	■

Figure 2. Task Schedule (Gantt Chart)

5.0 BUDGET PLAN

FTA's Funding Source and budget for this project are as follow:

49 U.S.C. Section 5312, FY 2016: $483,331
49 U.S.C. Section 5312, FY 2017: $966,669
Total FTA funds: $1,450,000

Letter of No Prejudice (LONP):

LA Metro has requested FTA to grant a Letter of No Prejudice (LONP). This LONP will enable Metro and its project partners to recoup the initial expenses related to contracting, project kickoff preparation, and other administrative activity that must occur before technical tasks can begin prior to development and approval of a cooperative agreement between FTA and Metro, which is expected by June 30, 2017. FTA approved LONP request on May 25, 2017.

Deferral Cost Match:

A deferral for cost share for each invoice submission has been requested for approval from FTA. Given the partnership with others and Metro's in-kind support, meeting the local match requirements for each and every invoice would not be possible. The cost share targets will be met cumulatively by the end of the project as follows: FTA Share 72.5%; LA Metro share 27.5%.

The Project Budget aligns with the Objective and Task structure scope. The budget to complete each project objective is shown in Table 1.

One of each selected collision and avoidance system will be purchased and installed as part of Objective 2. The remaining systems will be bought and installed as part of Objective 3.

Table 1. Budget Distribution by Primary Objectives / Tasks (all values USD).

	Fed. Share	Cost Share
Objective 1 – Define system requirements and select technology…	**48,373**	**40,000**
1.1 - Define Technology Requirements and Criteria		
1.2 - Evaluate State of Art against Requirements & Criteria		
1.3 - Select Technology for Demonstration		
1.4 - Provide Major Documents to FTA Program Manager		
Objective 2 – Develop Integration Plan and Test Prototype(s)…	**400,000**	**80,000**
2.1 - Develop Integration Plan		
2.2 - Procure Prototype Components		
2.3 - Install and Test System (closed track evaluation)		
2.4 - Provide Major Documents to FTA Program Manager		
Objective 3 – Install and Demo System(s) in Revenue Service…	**748,658**	**268,242**
3.1 - Develop Detailed Deployment Plan		
3.2 - System Installation		
3.3 - Conduct Driver and Maintenance Training		
3.4 - Demonstrate Technology in Revenue Service		
3.5 - System Disposition		
3.6 - Provide Major Documents to FTA Program Manager		
Objective 4 – Define Performance Metrics and Collect Demo Data…	**93,663**	**50,000**
4.1 - Confirm Key Collision Metrics & Data Collection Procedure		
4.2 - Collect Baseline Data (experimental control)		
4.3 - Collect Collision and Collision Avoidance Data		
4.4 - Collect Personnel Survey Data		
4.5 - Summarize and Report Data (Data Evaluation)		
4.6 - Provide Major Documents to FTA Program Manager		
Objective 5 – Manage Project Activity and Provide Oversight…	**127,806**	**52,509**
5.1 - Draft and Execute Contract and Subcontracts		
5.2 - Conduct Project Kickoff		
5.3 - Conduct Weekly Project Status Meetings		
5.4 - Track Action Items and Monitor Project Budget/Schedule		
5.5 - Draft and Distribute Quarterly Reports		
5.6 - Draft and Submit Final Report		
5.7 - Maintain FTA TrAMS Account		
Travel:	**31,500**	
Contingency:		**59,249**
Total:	**1,450,000**	**550,000**

6.0 FTA DELIVERABLES

The project team will submit the following documents/reports to the FTA project Manager per the schedule below:

SOW Draft – 5/1/2017
Performance Metrics Summary Table Draft – 5/1/2017
FFR, MPR, QPR – Quarterly throughout project timeline
Interim Technology Performance Report (Data Summary) #1 – Quarter 2, 2019
Interim Technology Performance Report (Data Summary) #2 – Quarter 4, 2019
Interim Technology Performance Report (Data Summary) #3 – Quarter 2, 2020
Project Report Draft – Quarter 2, 2020

Technology Performance Reports include a performance metrics summary. A draft of the performance metrics table is included in the Section 9.

7.0 REPORTING REQUIREMENTS

In accordance with the FTA reporting requirements, set forth in FTA Circular 6100.1E, Transit Research and Technology Programs Chapter 2, Section 5, the project team will submit the following reports/ electronic documents on FTA's Transportation Electronic Award and Management (TrAMS) System.

- Quarterly Progress (Performance) Reports (QPRs) briefly highlighting progress toward project objectives and potential problems, as well as relevant technical reports within 30 days of the end of calendar quarter to the FTA Project manager. Federal Financial Reports (FFRs) and Milestones Progress Reports (MPRs) are submitted through TrAMS. In case there are unforeseen developments that may possibly delay the submission of a report, the FTA project Manager will be informed as soon as possible. These reports will conform to the seven reporting requirements in the FTA Circular 6100.1E.

- Financial Status Report or federal form SF269A, along with project invoices will be submitted through Delphi eInvoicing system for reimbursement.

- Since FTA is required by 49 U.S.C. Section 5312 (Funding Source) to evaluate every demonstration project within two years after award, an interim report at 2-year mark will be provided to the FTA project manager.

- A Final Technical Report, conforming the FTA Circular 6100.1E style and elements specs, as well as copies of relevant technical publications/electronic web-ready documents, in Section 508 compliance format, will be submitted to the FTA project manager. In addition, a hard copy of the Final Report will also be sent by mail.

8.0 FTA DOCUMENTS / REFERENCES

Project shall refer to the following for grant management and documentations:

Circular 6100.1E
https://www.transit.dot.gov/regulations-and-guidance/fta-circulars/research-technical-assistance-and-training-program

FY17 Annual Certs and Assurances
https://www.transit.dot.gov/funding/grantee-resources/certifications-and-assurances/fta-fiscal-year-2017-certifications-and

FY17 Master Agreement
https://www.transit.dot.gov/funding/grantee-resources/sample-fta-agreements/changes-fta-master-agreement-fy-2017

All project applications for obligation, amendment and revision are electronic and should be done in TrAMS
https://www.transit.dot.gov/TrAMS/

Please refer to the following links in preparing a Final Report
https://www.transit.dot.gov/research-innovation/preparationinstructionsforftafinalreportsjune2013

Sample Final Reports
https://www.transit.dot.gov/research-innovation/research-innovation-reports-and-publications

Link below has general information about Delphi eInvoice System and training material
http://www.transportation.gov/cfo/delphi-einvoicing-system

See Evaluation and Data Requirements of NOFO (Section C4a) for additional information on Performance Metrics
https://www.transit.dot.gov/research-innovation/safety-research-and-demonstration-program

9.0 PERFORMANCE METRICS

Performance metrics are established in order to measure the effectiveness of the collision avoidance and mitigation technology in an urban setting, and to determine if the project meets FTA SRD program goals and objectives.

The team will assess the effectiveness of the collision avoidance and mitigation systems by collecting and analyzing technical performance data during the 18-month demonstration. The metrics that will be tracked during the demonstration are shown in the Performance Metric Summary table below. These metrics allow the team to judge the Safety Improvement, return on Investment, and Commercialization Potential of the collision avoidance and mitigation

technology. The results of the team's assessment can be used by LA Metro and the general transit industry when making decisions to adopt and deploy similar technology in other locations and applications. The project has the potential to identify technology that can deliver long-term human safety, cost reduction, operation up time, and public relation benefits to both transit operators and transit users. Furthermore, the impact that this project can make to the transit industry is amplified because the project team includes New Flyer. As a leading transit bus provider to the North American market, New Flyer has substantial impact on the availability and adoption of new transit bus technologies. By being involved in the project, New Flyer will have the opportunity to review system performance first-hand and more quickly make commercial decisions about advanced collision avoidance and mitigation technology.

In order to effectively track the performance metrics shown in the Performance Metrics Summary table, the team will utilize a variety of data collection and feedback tools. Describing these tools in detail are not possible at this time because it requires a detailed understanding of the data capture and communication capabilities of the specific systems that are to be used during the demonstration, which will not be identified until Task 1 is complete. However, regardless of what systems are selected for demonstration, all of the quantitative (e.g. number of collisions reduced) and qualitative (e.g. survey of drivers for opinion on tactile/audible/visual system feedback) metrics outlined in the summary table will be tracked during the demonstration. Ultimately, these are the metrics that will allow the team to assess the Safety Improvement, Return on Investment, and Commercialization Potential of the collision avoidance and mitigation technology.

NOTE: In order to achieve a comprehensive understanding of the impacts and implications of each proposed SRD demonstration, FTA or its designated independent evaluator, may require direct access to project data. These data will be used by FTA to conduct program evaluation during the execution and at the end of the project. Regardless of the FTA's independent evaluation, LA Metro will perform the project evaluation and complete the analysis using the metrics outlined in this section.

In addition to measuring the effectiveness of the collision avoidance and mitigation systems, the team intends to address FTA SRD program goals and objectives, outlined below.

SRD Program Objective 1: Explore advanced technologies to prevent transit vehicle collisions.

> The demonstration phase of the project explores the effectiveness of a collision avoidance system in an urban transit system environment. While not necessarily designed nor optimized for such an operating environment, the demonstration will assess the effectiveness of the system(s) and offer the opportunity to suggest modifications to the technology provider to improve performance for the transit industry.

SRD Program Objective 2: Enhance safety of transit services by incorporating safer design elements.

> New Flyer's interest in this project stems largely from their desire to offer a collision avoidance system as an option on their buses, incorporating safer design elements. This

commitment will eliminate the need for transit agencies to purchase and install the system as an after-market solution.

SRD Program Objective 3: Evaluate cost-effectiveness and practicability of potential solutions.

The project includes an assessment of the return on investment to be realized by the transit agency as well as a qualitative assessment of transit personnel's experience with the technology. The return on investment assessment will help determine the cost-effectiveness of the system(s). The qualitative assessment will help the team understand the practicality of the system(s) in daily operation. From an OEM perspective, New Flyer will be able to optimize the integration of the collision avoidance system with other critical bus systems such as braking and driver information systems to achieve the highest level of performance in terms of human driver assistance and public safety benefits at a commercially effective cost.

Performance Metric Summary table:

	Safety Improvement							
Metric	# and Type of Incident (experiment group)	# and Type of Incident (control group)	# and Type of Incident (historical occurrences)	% collision reduction	% collision reduction w/ pedestrians	% collision reduction w/ bicyclists	% collision reduction w/ motorized vehicles	# of false positives
Instrument Used	TransitSafe (event database)	TransitSafe (event database)	TransitSafe (event database)	statistical analysis	statistical analysis	statistical analysis	statistical analysis	TransitSafe (event database)
Frequency	once per shift throughout demo	once per shift throughout demo	once per shift throughout demo	every 6-months throughout demo	every 6-months throughout demo	every 6-months throughout demo	every 6-months throughout demo	once per shift throughout demo

	Commercialization Potential			ROI*
Metric	Driver Opinion	Maintenance Staff Opinion	Public Stakeholder Opinion	TBD (e.g. 1 year, 6 year, 12 year)
Instrument Used	survey	survey	survey	data from demo, historical data, and cost estimates
Frequency	every 6-months throughout demo	every 6-months throughout demo	every 6-months throughout demo	once during project

* ROI will be calculated using production-level component and installation cost estimates, data from the technology demonstration, and historical transit industry collision data. Furthermore, the ROI period has not yet been determined but will be defined by stakeholders before the data collection and reporting tasks begin.

10.0 KEY PERSONNEL

Michael Chang previously designed agricultural & industrial components at John Deere and developed servo-controlled actuators for aerospace products at Textron and ITT. He joined LA Metro in 2000 and has been serving as lead engineer on major bus procurements. They included (370) 40-foot buses, (200) 60-foot articulated buses and (301) 45-foot composite-body buses from NABI. In the last five years, he successfully introduced to LA Metro a fleet of (900) 40-foot Xcelsior buses built by New Flyer. He received a master's in Mechanical Engineering from the University of Iowa and has been a registered Professional Engineer in Iowa and California. For six years starting in 2000, he sat on the Hearing Board of the Southern California Air Quality Management District as an alternate engineer member.

Diego Ramirez is a Manager Transportation Planner, at Los Angeles County Metropolitan Transportation Authority since 2008. Responsible for management, compliance oversight and reporting for select FTA grant awarded funds under Section 5316 and Section 5317 to sub-recipients. Collectively these grants total over $39 million and were awarded either through TEAM or TrAMS from the FTA grants systems. Prior to Metro he was involved in oversight for commercial and private real estate loans through Wachovia Bank N.A.

Thomas Small, is a Professional Engineer and a graduate of the University of Manitoba Faculty of Engineering (1994). He started his mechanical engineering career in agricultural equipment at New Holland Canada (now Buhler Versatile) in Winnipeg testing and designing tractors for agricultural applications.

In 2000, Mr. Small moved to the Winnipeg-based transit bus manufacturer, New Flyer Industries. In this fast-paced environment, he progressed through the Production Engineering Department to the New Product Development Department where he managed multiple large scale projects with emphasis on advancing powertrain technology over 11 years as a Project Engineer. Since 2012, Mr. Small manages a high performance team of engineers and technicians as the Director of the New Product Development Department overseeing the development of large scale emerging technology projects such as Battery Electric buses, Fuel Cells, and now stages of autonomous vehicle development.

Blake Whitson is a Technical Project Manager at CTE. Mr. Whitson provides management support for advanced transportation projects, including battery-electric and hydrogen fuel cell powered vehicle deployments. He also performs route analysis, vehicle modeling and simulation, and rate modeling activities to determine the feasibility of alternate fuel vehicles for client applications. Other responsibilities at CTE include estimating energy consumption and charging costs for bus deployment projects and conducting Buy America compliance assessments for transit bus procurement projects. Prior to CTE, Mr. Whitson was an Advanced Manufacturing Engineer at BorgWarner. He holds a Bachelor of Science in Mechanical Engineering from Clemson University.