Safer Autonomous Work Zones (SAWZ)

Applicant: Oklahoma Department of Transportation
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OKLAHOMA
Transportation

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PROJECT NARRATIVE

PROJECT DESCRIPTION

Oklahoma Department of Transportation (ODOT) is proposing a plan (the Project) to implement connected and automated vehicle technologies and integrate real-time work zone data into statewide maintenance operations via Autonomous Truck Mounted Attenuators (ATMA). This Project will deploy an ATMA pair as a pilot program to evaluate how this technology can be implemented into ODOT maintenance systems, how the technology can increase the overall safety for mobile work crews, demonstrate how ATMA's can help address maintenance worker shortages, and pilot integrating real-time data from mobile work zones into ODOT's Intelligent Transportation System (ITS) and Work Zone Data Exchange (WZDx). A successful Stage 1 SMART Grant Project will support evaluation and planning efforts for deploying the technology statewide, leading to the potential for a Stage 2 SMART Grant to procure additional vehicle pairs, complete integration of work zone data, and train crews statewide.

Project Goals:

- Implement ATMA technology into ODOT processes statewide
- Increase safety in work zones
- Address maintenance worker shortages
- Integrate real-time data into ODOT's ITS System and Work Zone Data Exchange

This Project falls into the technology categories of connected vehicles, intelligent sensor-based infrastructure, and systems integration. The Project will address the safety goals of the SMART program and the strategic goals of safety, reliability, and resiliency of the U.S. Department of Transportation (U.S. DOT) by creating safer conditions for the public and ODOT maintenance workers, allowing ODOT to "do more with less", and providing a pathway for other states to incorporate autonomous maintenance technologies into their everyday operations.

PROJECT LOCATION

The Project will be tested in strategic locations throughout Oklahoma, excluding Oklahoma City and Tulsa. These cities are excluded because they have local maintenance operations. By excluding these cities, the Project will only serve midsized and rural communities. Of these communities, **41 percent of the census tracts are identified as Historically Disadvantaged Communities (HDC).**[1] The Systems Engineering process will be used to identify user needs across all functional and geographic maintenance areas of ODOT's primary responsibilities. User needs will then be prioritized by the Project team, resulting in the selection of functions and locations to be included with the evaluation portion of this Project.

[1] https://usdot.maps.arcgis.com/apps/dashboards/d6f90dfcc8b44525b04c7ce748a3674a

COMMUNITY IMPACT

As noted above, the Project will benefit HDC communities outside of Oklahoma City and Tulsa as it is intended to **provide safer and more consistent operations in work zones for maintenance workers** and the public, and it will integrate real-time data regarding work zones into ODOT systems to **improve traveler knowledge of the status and location of mobile work crews**. One negative externality would be that the ATMA vehicle pair requires an ITS engineer to be on site to program the vehicles for maintenance functions. During Stage 1, ODOT plans to provide training to their maintenance workers to educate them how to program the ATMA vehicle pair, removing the need for an engineer to be on site.

TECHNICAL MERIT OVERVIEW

IDENTIFICATION AND UNDERSTANDING OF THE PROBLEM TO BE SOLVED

Over the **past 5 years**, there have been **91 deaths** in **work zones** in Oklahoma, including one ODOT worker. (ODOT Safety, 2022)

ODOT recognizes the need to increase safety in work zones across Oklahoma for workers and the public. To do so, it will be important in Stage 1 to test how the Project can be implemented into existing ODOT processes across the state. Existing TMAs need a driver, which puts that maintenance worker in danger when the vehicle gets hit. Additionally, ODOT currently is facing worker shortages in their maintenance crews and have experienced an increase in accidents in work zones statewide.

ODOT has already procured one lead/follow ATMA vehicle pair. This ATMA pair will allow a quick start to the Project and focus grant funding on supporting the development of tools, techniques, practices, and procedures, as well as measures of effectiveness for a scaled deployment of ATMA's in identified strategic areas throughout Oklahoma. Additionally, ODOT has already established and published a WZDx per the U.S. DOT specifications, so the Project will build upon the digital infrastructure already in place by piloting the addition of mobile work zone data and coordinating with the Work Zone Data Working Group (WZDWG).

APPROPRIATENESS OF PROPOSED SOLUTION

ATMA vehicles, also known as Autonomous Impact Protection Vehicles (AIPV), may have different system designs and hardware/software setups, but usually include a leader vehicle, a follower vehicle with the TMA, and a leader-follower pair that enables the follower to drive autonomously and follow the leader. This type of system was pioneered in the U.S. by Kratos Defense & Security Solutions. Kratos has deployed at least 13 ATMA systems across the United States and in the United Kingdom, totaling over 2,500 miles since 2017. Therefore, ODOT has acquired one lead/follower vehicle pair from Kratos, as their systems

Source: Autonomous Truck Mounted Attenuator (ATMA) Pilot

are sufficiently developed. Any modifications deemed necessary through the course of this Stage 1 Project will be documented such that additional vehicles could be added to the fleet via a Stage 2 SMART deployment grant, allowing for the solution to be repeated statewide and rapidly scaled across locations as needed.

ODOT has chosen to outfit a pickup style vehicle designed for any normal maintenance work as the leader vehicle for this Project. The follower truck with a TMA will use autonomous car-following a few hundred feet to half a mile behind the leader, with a work crew and their vehicle(s) between the ATMA pair. This is the most appropriate solution for ODOT to adapt to different types of applications, meet the Project goals, and improve upon existing maintenance operations. Specifically:

- This ATMA vehicle pair design increases **safety** by removing DOT employees from the follower vehicle and eliminating injuries while they are following a crew performing slow moving operations.
- Diverse staff can be trained on use of the pickup/TMA pair for any operation requiring a mobile crash cushion, addressing **worker shortages** and creating more desirable jobs.
- The pickup/TMA pair can be used for different operations for **maintenance process improvement statewide**, not just for one specific function like painting. SOPs will be developed where specific maintenance operations require unique applications of the technology.
- The ATMA vehicle pair can be setup to broadcast the start/end of the work crew, workers present, location/speed, lane(s) effected, lane status, and other elements of the **Work Zone Data Exchange** "WorkZoneRoadEvent" object.

EXPECTED BENEFITS

From 2017-2021, there were **over 7,000 crashes in work zones** on Oklahoma highways **statewide** (Provided by the ODOT Traffic Division, 2022).

To reduce crashes and fatalities in work zones, truck mounted attenuators are utilized because they are designed to absorb the impact of high and low speed crashes. However, operators of these vehicles are placed in harm's way as these vehicles are awaiting to be struck. This Project would test deployment of a ATMA lead/follower vehicle pair throughout Oklahoma work zones across one construction season. The Project, combined with existing work zone safety initiatives, will improve the safety and reliability of maintenance operations to better protect the ODOT workforce and public drivers. The ATMA's will allow ODOT to "do more with less" since these vehicles do not require a driver position to be filled and can be deployed across the state where needed.

The Project Concept of Operations (ConOps) will provide a high-level understanding of how the system will work within ODOT's maintenance processes, system requirements that will outline how the Project will meet user needs, and Standard of Operating Procedures (SOPs) that will define how ATMA's will be incorporated into ODOT operations throughout the state.

The data collected throughout Stage 1 will be used to determine if the ATMA pair was successfully implemented into ODOT maintenance functions. The expectation is that these vehicles will create efficiencies for maintenance workers on the job site, as well as travel time savings and reliability for the public. The Project's success would allow for a scaled deployment of ATMA's in identified strategic areas throughout Oklahoma. If these goals are met by this Project, ODOT will move forward with procuring additional vehicles for deployment throughout the state. ODOT will also share the results with Oklahoma Cities and Counties as well as other Departments of Transportation (DOTs) throughout the country for their implementation.

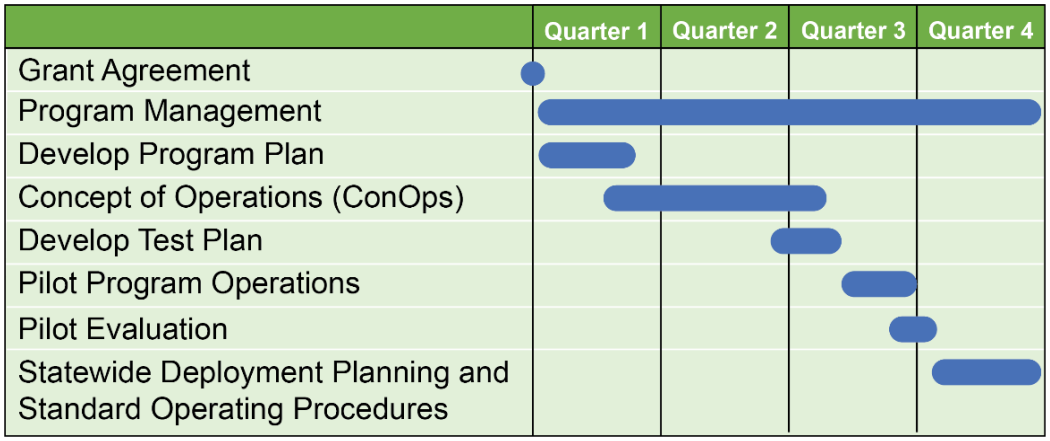
PROJECT READINESS OVERVIEW

FEASIBILITY OF WORKPLAN

Workplan and Timeline

The Project can be completed over a 12-month timeframe, as shown in **Figure 1**. The major elements of the work plan are described below.

FIGURE 1: PROJECT SCHEDULE



Program Management:

Program Management includes ongoing grant administration, contract administration, and budget management. Also included is a program management plan and quality management plan. Routine team and Project Management Team meetings will be held throughout the Project.

Develop Program Plan:

The Program Plan will consist of a Master Schedule and Systems Engineering Management Plan (SEMP). The SEMP will document the plan to execute the systems engineering activities. This will include developing a process to solicit stakeholder input and identify deployment challenges.

Concept of Operations and Engagement:

The Concept of Operations phase of work will include a robust stakeholder and public outreach program including virtual stakeholder workshops to discuss user needs, operational scenarios, stakeholder roles and responsibilities, and concepts for the proposed system. The ConOps will identify user needs, define the concept, provide operational scenarios for different mobile maintenance functions, and integration into ODOT's Work Zone Data Exchange.

Develop Test Plan:

The Pilot Evaluation Plan (PEP) will outline the Project evaluation vision, goals and objectives identified in the grant application and related evaluation questions and will detail the evaluation methodology for each measure. A Data Management Plan (DMP) will detail how the data will be collected, quantified, evaluated and reported to FHWA, as well as known data risks and limitations.

Pilot Program Operations:

The operations phase includes Test Case Setup and Test Case Execution. Once the basic test environment is setup, a comprehensive set of test cases will be performed to evaluate the ATMA across different maintenance operations. After initial baseline testing, the team will make installation and configuration parameter recommendations for next steps and field setup/installation of the hardware/software required.

Pilot Evaluation:

The team members will lead development of a report that details both the quantitative metrics and the qualitative assessment gathered from users of the ATMA. The quantitative metrics will be derived from vehicle data, video cameras, and GPS-equipped maintenance vehicles. Additionally, safety data will be incorporated from crash report forms and surrogate safety measures will be derived from video. Qualitative metrics will be determined by surveying system users.

A final report will be compiled that includes results of the PEP including quantitative and qualitative assessments; a System Verification Report; Acceptance Testing Results; and, Lessons learned & recommendations for future enhancements.

Statewide Deployment Planning & Standard of Operating Procedures:

This step of the Project will develop a Stage 2 Plan for incorporating ATMA's into operations statewide. Included with this will be a catalog of Standard Operating Procedures for use by ODOT in the continued use of the pilot device and expansion of the program to additional locations.

Legal, Policy, and Regulatory Requirements

Senate Bill 189[2] in 2019 exempts platoons from spacing requirements on state highways. This bill allows for the platooning of autonomous vehicles. Senate Bill 1541[3] in 2022 allowed for the operation of fully autonomous vehicles in Oklahoma. These two bills have paved the way for autonomous vehicles in the State. Existing legislation will allow for ODOT to begin implementation immediately for any future ATMA programs. There are not any required waivers, permits, or special permissions needed to conduct the Project.

Expected benefits

The Pilot Evaluation Plan will analyze quantitative and qualitative metrics to define performance of the ATMA vehicle pair. The information gathered will help fine tune the Project as it rolls out statewide in Stage 2. Since the vehicles are autonomous, maintenance operations will be more efficient and reliable, which will lead to a safer work zone for the public and ODOT workers.

The Project will include a ConOps and a Pilot Evaluation Plan. The ConOps will include stakeholder engagement to ensure user needs are identified and define the overall need for the Project. This will inform the benefits and the impacts that the Project has on the community that it is deployed in.

Training and Education Programs

The Statewide Deployment Plan and SOPs will define a formal training and education program for use of ATMA's by ODOT. Training material will be developed to clearly define maintenance responsibilities and associated agency personnel for devices, management, authorized uses, etc. Training in the use of automation will be an overall benefit to the maintenance work force, creating more desirable jobs. Incorporation of this technology also will allow a broader range of staff to operate mobile work zones and the ability to swap equipment and workers between operations, leading to a more resilient program with fewer silos and less reliant on specific operators.

Planning and Engagement Activities

The loss of jobs has been a common concern by the public in shifting to autonomous vehicle operations in other industries; however, this Project will help ODOT with their shortage of maintenance workers. ODOT currently has **135 vacancies** for transportation equipment operations statewide. ODOT has been having **difficultly filling vacant positions**, an issue for departments of transportation nationwide. The existing position for a maintenance worker to operate the TMA is dangerous because these vehicles are designed to be hit. ATMA's will provide the opportunity for operators to be placed in a safer position on the job site, which will help ODOT fill maintenance vacancies in their workforce.

[2] http://www.oklegislature.gov/BillInfo.aspx?Bill=sb189&Session=1900
[3] http://www.oklegislature.gov/BillInfo.aspx?Bill=SB1541&Session=2200

COMMUNITY ENGAGEMENT AND PARTNERSHIPS

Don't Zone Out: ODOT Work Zone Safety

Throughout the planning process of Stage 1, ODOT will engage with stakeholders across Oklahoma through social media to educate the community about ATMA's and proposed Project locations throughout Oklahoma. Robust engagement will be planned to provide the public with information about the Project and its goals to improve maintenance operations reliability, safety, and resiliency throughout the state. Surveys will be deployed via social media to gain stakeholder feedback from the public about their opinions on the ATMA vehicles. Surveys will also be deployed to ODOT maintenance workers to document their experience working alongside the ATMA vehicles to see how existing concerns were made better or worse by this vehicle implementation.

By working with Kratos, ODOT will be engaging with private sector technical experts throughout the planning process, incorporating best practices and lessons learned from other deployments similar to this Project. The results of the Project will be made available for potential use by all cities and counties.

LEADERSHIP AND QUALIFICATIONS

The following Project Management Team has been organized to ensure that the Project includes the expertise needed to successfully implement and test the procured ATMA vehicle pair into ODOT operations statewide. The primary point of contact for the Project will be Lauren January, ODOT State Traffic Engineer. Bios for all key staff, which define their technical expertise to deliver this project can be found in *Appendix I: ODOT Resumes.*

Lauren January, P.E. – ODOT State Traffic Engineer

- Responsible for Project management

Alan Stevenson, P.E. – ODOT Assistant Division Engineer for ITS & Operations

- Responsible for oversight and implementation of the ATMA technology into ODOT maintenance functions

Taylor Henderson, P.E. – ODOT State Maintenance Engineer

- Responsible for oversight and implementation of the ATMA technology into ODOT maintenance functions as well as monitoring the Project budget

James "Marty" Farris, P.E. – ODOT State Highway Safety Engineer

- Responsible for data collections associated with the Project

APPENDICES

APPENDIX I – RESUMES

Lauren January, PE

Lauren is the ODOT State Traffic Engineer and she leads the Traffic Engineering Division which includes Planning and Analytics Branch, Safety and Collision Branch, Operations, Work Zone Team, Sign Shop, Traffic Data Collection, Sign Programs, and Signal Maintenance. Ms. January has served as the Assistant State Traffic Engineer and an Engineering manager where she led the Geometrics and Operations Design Group, administered and reviewed Interstate Access Justification Reports for the entire state, conducted operational analysis utilizing VISSIM, HCS, and Synchro, and coordinated the update to the ODOT Roadway Design Manual. Ms. January has a Bachelor of Science in Civil Engineering from the University of Oklahoma, May 2008.

Alan Stevenson, P.E.

Alan is the Assistant State Maintenance Engineer for the Oklahoma Department of Transportation. Alan oversees all technology deployed on ODOT's highway system thru the ITS, Smart Work Zones, Fiber Optics and LMR Wireless Branches. Alan has been working in ODOT for the past 34 years, duties included the oversight of the design, operations, maintenance, and development of construction plans for ITS, Smart Work Zones, Fiber Optics and LMR Wireless deployments. Alan is also responsible for the negotiations of public private partnerships with third party Telecommunications Companies and the overseeing of engineering and asset management of all ODOT, OTA and the State's fiber optic inventory in a GIS platform.

Taylor Henderson, P.E

Taylor Henderson is the State Maintenance Engineer for Oklahoma. Mr. Henderson has spent most of his career with the Department of Transportation, 15 years in construction and 10 years in maintenance. Mr. Henderson currently oversees all ITS, Smart Work Zones, Fiber Optics, LMR Wireless, Motor pool, Beautification, Pavement Management, ER, FEMA operations. He also develops the statewide Maintenance Budget, the Maintenance Quality Assurance (MQA) program, and the Maintenance Management Systems (MMS) program. He received his bachelor's degree in Civil Engineering from Oklahoma State University in 1998, and then obtained his master's degree in Civil Engineering with a Project Management emphasis from Oklahoma State University in 2000.

James "Marty" Farris, P.E

Marty is the State Highway Safety Engineer for the Oklahoma Department of Transportation. He manages the collection and analysis of collision data for the State of Oklahoma. He began his career with ODOT in 2009, and has previous experience in Intelligent Transportation Systems, Roadway, and Bridge Design Divisions.

APPENDIX II – SUMMARY BUDGET NARRATIVE

The cost shown below in ***Table 1*** describes the information contained in the SF-424A form submitted with this application. The tasks below are defined in the ***Feasibility of Workplan*** section above.

TABLE 1: ESTIMATED PROJECT COST

Task Name	Personnel	Travel, Equipment, Supplies	Other (Consultant Costs)	Totals
Program Management	$ 90,000.00	$ 1,200.00	$ 90,000.00	**$ 181,200.00**
Develop Program Plan	$ 12,000.00	$ 1,800.00	$ 36,000.00	**$ 49,800.00**
Concept of Operations & Engagement	$ 18,000.00	$ 10,800.00	$ 174,000.00	**$ 202,800.00**
Develop Test Plan	$ 30,000.00	$ 1,800.00	$ 180,000.00	**$ 211,800.00**
Pilot Program Operations	$ 48,000.00	$ 42,000.00	$ 90,000.00	**$ 180,000.00**
Pilot Evaluation	$ 18,000.00	$ 1,200.00	$ 60,000.00	**$ 79,200.00**
Statewide Deployment Planning & SOPs	$ 18,000.00	$ 6,000.00	$ 114,000.00	**$ 138,000.00**
	$ 234,000.00	**$ 64,800.00**	**$ 744,000.00**	**$ 1,042,800.00**

APPENDIX III – LETTERS OF COMMITMENT

ODOT is responsible for the management, planning, and implementation of the Project. ODOT is committed through its mission to provide a safe, economical and effective transportation network for the people, commerce and communities of Oklahoma. ODOT has a proven record of effectively administering federal grant funding and will ensure all agreed-upon components of the Project are successfully managed, tracked, and implemented.