



Autonomous Truck Law Enforcement Interaction Procedure

Introduction

This document outlines Embark's law enforcement interaction procedure, which specifies a process by which law enforcement can execute a routine traffic stop of an autonomous truck operating without a human occupant.

Background

The commercial deployment of SAE Level 4 autonomous trucks on public roads has the potential to dramatically improve the safety and efficiency of freight trucking. The operation of trucks via an Automated Driving System (ADS) and without a human driver can eliminate the most frequent causes of commercial motor vehicle crashes, injuries, and fatalities, such as human error due to misjudgment, impairment, fatigue, or distraction. Furthermore, autonomous long-haul truck operations can provide significant efficiencies by operating beyond hours of service limits intended to prevent fatigued human driving.

In order to deliver the benefits of autonomous trucking, this technology will need to be deployed within the existing operational freight trucking ecosystem. Developers of autonomous trucks must not only build a system that can drive safely down the road, but also the capability for these trucks to operate alongside human-driven vehicles and successfully engage with the broad range of scenarios, incidents, and interactions that arise in a public road environment.

From the perspective of an autonomous truck developer, successful law enforcement interaction requires two components. First, the Automated Driving System (ADS) must have the technical capability via hardware and software to detect a law enforcement vehicle, confirm its intention to initiate a traffic stop, and safely maneuver the vehicle to an appropriate location on the side of the road. Second, once stopped, the autonomous vehicle must make available its status and any required information to the law enforcement officer. This document focuses on the development of the second component.

Traffic Stops for Autonomous Commercial Vehicles

In the highly regulated road environment, local, state, and federal law enforcement officers all may be certified to inspect commercial vehicles and enforce the Federal Motor Carrier Safety Regulations, and state and local law enforcement officers also have the authority to enforce applicable rules of the road. These enforcement actions routinely occur during traffic stops, in which a law enforcement officer signals a vehicle via visual and audio cues that it must pull over so the officer can examine the driver's credentials, vehicle registration, the physical condition of the truck, and anything else necessary to demonstrate compliance with all applicable laws.



With conventional human-driven trucks, these traffic stops center around interaction between the officer and a commercial driver, who is able to furnish the information and documents necessary, as well as receive any citations or other paperwork issued by the officer.

Autonomous commercial vehicle operation requires a new approach that will provide a law enforcement officer with a comparable opportunity to collect information about the commercial vehicle's operational status, investigate compliance, and convey information back to the entity responsible for commercial vehicle operation. In addition to replicating the contours of a conventional traffic stop, an autonomous truck traffic stop must also address new issues, such as how an officer can determine the vehicle is safe to approach without being able to observe the actions of a human driver.

Procedure Criteria

Embark considered a number of criteria and constraints when developing and refining a procedure for law enforcement interaction with autonomous trucks. In the abstract, a wide range of solutions can be imagined with varying levels of cost, infrastructure, technology, and engineering requirements. To narrow our solution set, Embark held conversations with a range of law enforcement officers in a number of states over several months to better understand their needs, concerns, and ideas. The result of these conversations yielded a clear signal of how an ideal solution should be developed:

Broad Applicability: Embark's commercial deployment plans center on multistate long-haul operation of autonomous commercial motor vehicles. Such a route would pass through a variety of local, county, and state law enforcement agency jurisdictions. Therefore, any solution should not be specific to a particular agency, but rather something that can be easily adopted across many jurisdictions.

Cost: Law enforcement agencies must address a wide range of public safety needs with limited budgetary resources. Given the current pre-deployment nature of autonomous trucks, it is unrealistic to have a law enforcement interaction solution that requires public sector investment. This is especially true when considering the need for a solution that works across numerous jurisdictions. Therefore, anything that would require law enforcement to adopt new equipment, hardware, or software to successfully execute a traffic stop of an autonomous vehicle was considered infeasible.

Training Requirements: Law enforcement officers are highly trained professionals who are tasked with a wide range of public safety responsibilities. While some officers specialize in commercial vehicle enforcement and receive extensive training for this purpose, any officer must be able to safely and successfully implement a traffic stop of an autonomous truck if needed. Embark focused on a solution that would be as intuitive as possible based on existing traffic stop procedures, and therefore would not require



specialized training of law enforcement.

Interaction Methods: The highway shoulder road environment can be dangerous, noisy, and exposed to all weather conditions. Any means of communication incorporated in the interaction procedure must be resilient to these disruptions and allow an officer to complete the traffic stop in an efficient manner.

After consideration of the above constraints, Embark worked with the Travis County Sheriff's Office (TCSO) and the Texas Department of Public Safety (Texas DPS) to develop and test a solution that would meet the needs of both law enforcement and the autonomous trucking industry.

Law Enforcement Interaction Procedure

The following procedure is intended to address a routine traffic stop of an autonomous truck. Variations in traffic stop procedures exist across departments, and even across officers from the same department. This procedure attempts to create a standard method that is compatible with the most common ways that commercial vehicles are stopped.

Users:

- **Law Enforcement Officer (LEO):** this is the vehicle-based officer who has identified an issue with the truck and is pulling it over
- **Embark Guardian Support Technician:** this is the Embark team member in the Guardian Control Center who will be supporting the interaction remotely via phone and the Guardian truck interface

Nominal Journey:

1. LEO decides to initiate a traffic stop of an autonomous truck
2. LEO turns on lights and positions their vehicle to indicate to the truck that it should pull to the side of the road.
 - a. Sirens are often not used in highway situations as they may not be audible to truck drivers given road noise, cab sound insulation, and distance between cab and LEO vehicle.
 - b. Given that the area immediately behind a trailer is not visible to the driver, LEOs often "peek out" and position themselves offset from the rear of the truck. Other common maneuvers include passing the truck and taking a lead position in front of the truck to "guide" it onto the shoulder.
3. Based on the LEO actions, the truck's Automated Driving System identifies that it is being requested to pull over and sends a confirmation request to a Guardian Support Technician.
4. Guardian Support Technician reviews the video stream and confirms that the truck should pull over.

- a. In the event that the truck doesn't receive a response from the Guardian Support Technician in a given window, it will make the default assumption that it is indeed being pulled over.
5. The truck pulls safely to the shoulder (fully out of the lane, in a clear area).
6. LEO pulls over, usually behind the truck but also possibly in front of truck depending on the maneuver used in #2.
7. LEO approaches the truck from the passenger side to keep the truck between the LEO and road traffic.
 - a. If the LEO approaches from the driver side, a large decal directs them to the passenger side
 - b. At the passenger side of the truck, the LEO can see:
 - i. A large decal indicating a phone number to call for support
 - ii. A digital display clearly indicating whether the autonomous vehicle is safe to approach
 - iii. A combination lockbox that contains compliance documents such as truck registration, proof of insurance, and bill of lading



Prototype LEO interaction features, including autonomous truck status display (top, currently off), support phone number decal, and compliance document lockbox.



Example of status screen indicating autonomous truck is safe to approach after stopping on the highway shoulder.

8. LEO calls the phone number displayed and reaches a Guardian Support Technician.
9. LEO confirms the identity and location of the specific truck.
10. Guardian Support Technician ensures that the truck ADS is in *Disengaged* state via remote connection. LEO confirms that the status of the truck is *Disengaged/Safe to Approach* via the display on the truck side.
11. LEO and Guardian Support Technician discuss the issue for which the truck was pulled over.
12. If LEO needs to see documentation, they would be instructed by the Guardian Support Technician to open the physical lockbox accessible from the exterior of the vehicle.
13. The Guardian Support Technician provides the code to unlock the lockbox
 - a. LEO opens lockbox and accesses physical documentation.
 - b. LEO replaces any documentation when finished and closes the lockbox.
 - c. If a proof of traffic stop or physical citation is produced, it can also go inside the lockbox to be retrieved by support personnel at the end of the route.



Example of a LEO reviewing autonomous truck documentation obtained via lockbox

14. LEO concludes conversation with Guardian Support Technician, either giving go-ahead to resume driving or detailing the issue that grounds the truck.
 - a. Often, LEOs will assist the truck getting back on the road by turning on lights and blocking traffic in the rightmost lane so the truck can safely merge onto the highway. The LEO can discuss such a maneuver with the Guardian Support Technician and the activation of the ADS can be coordinated as needed.
15. The Embark team addresses the issue for which the truck was pulled over, and if possible, the truck resumes its journey.
 - a. If there is an issue that prevents resuming (such as Out of Service criteria), the truck will be retrieved from the side of the road.
 - b. If resuming, the truck pulls safely back onto the road.

Conclusion

This document presents a novel procedure designed to enable a law enforcement officer to execute a routine traffic stop of an autonomous commercial vehicle operating on highway without a human driver. The procedure is designed to be: 1) broadly accessible to all law enforcement agencies without additional equipment, investment, or training; 2) equivalent to a conventional traffic stop in terms of availability of information and documentation; and 3) provide certainty to law enforcement officers regarding the safety of approaching the vehicle. We hope it



can provide a template for law enforcement interaction for the broader autonomous truck industry and law enforcement communities across North America.

Embark would like to thank the Travis County Sheriff's Office, the Texas Department of Public Safety, the California Highway Patrol, and the Commercial Vehicle Safety Alliance for their assistance in providing data, feedback, and testing support during the development of this procedure. We are grateful for their unwavering commitment to improving the safety of public roads.