



October 28, 2021

**VIA ELECTRONIC MAIL**

PennDOT Central Office

Office of the Secretary  
Commonwealth Keystone Building  
400 North St., Eighth Floor  
Harrisburg, PA 17120

Re: Argo AI, LLC – Testing with a Single Safety Driver

To Whom It May Concern:

As you know, Argo AI, LLC, a Delaware limited liability company, (“Argo”), has received an Authorization Letter from the Pennsylvania Department of Transportation (“PennDOT”) allowing Argo to test highly automated vehicles (“AVs”) through November 1, 2021, and has requested authorization for continued testing in the future. Argo operates in accordance with PennDOT’s Automated Vehicle Testing Guidance, pursuant to which Argo wishes to submit the attached Single Safety Driver Testing Plan (“SSD-TP”) to expand Argo’s testing abilities to permit the use of a single safety driver.

The SSD-TP submitted herewith contains Argo’s internal processes, testing procedures, and operational design domain parameters, which constitutes or reveals “Trade Secrets” as defined within 65 P.S. §67.102, and constitutes or reveals confidential proprietary information. Therefore, the information included in the SSD-TP is exempt from access by a requester pursuant to 65 P.S. §67.708(b)(11). Argo is entitled to notice of a request for the SSD-TP and an opportunity to respond under the procedure set forth in 65 P.S. §67.707(b).

If you have any additional questions or concerns please contact us via email at [REDACTED]

Sincerely,

Argo AI, LLC

Single Safety Driver Testing Plan (“SSD-TP”)

1. **A description of any operating procedures that differ from standard operating procedures (i.e. two associates in the AV).**

The following operating procedures have been modified to accommodate testing with a single safety driver:

Procedure Category	Two Safety Drivers	Single Safety Driver
Communication	Commentary driving and communication between both safety drivers	Single safety driver engages in commentary driving monitored by a driver monitoring system
	Right-seat safety driver (“secondary safety associate”) utilizes a laptop to monitor and communicate comprehensive AV operating information to the left-seat safety driver	AVs are equipped with a single safety driver visualization system that provides the single safety driver with comprehensive AV operating information. The single safety driver visualization system consists of a centrally located visualization screen connected to the Automated Driving System (“ADS”), and runs a visualization tool displaying turn-by-turn directions for the AV’s route, and a trajectory that shows exactly what the AV will be doing up to a certain amount of time ahead of its current action
Operational Reporting	Secondary safety associate responsible for responding to operational advisories, managing incident response procedures, and troubleshooting via laptop	Single safety driver manages all responses via a mounted touch screen or a laptop stored in vehicle once stopped
	Secondary safety associate communicates end-of-shift/return home	Single safety driver communicates via mounted touch screen
Annotation	Secondary safety associate responsible for typing annotations for event logging via laptop	Single safety driver verbally records driver annotations for event logging
Driver Monitoring	Secondary safety associate monitors the time and manages breaks	Remote operations monitors and communicates to the single safety driver
	Both safety drivers responsible for	An in-vehicle driver monitoring system utilizes

	responding to driver alerts and providing support to each other to help maintain focus	infrared cameras to continuously monitor driver attentiveness and alert the single safety driver and remote monitoring team if the driver’s attention is not properly focused
	Secondary safety associate operates climate controls, radio, etc.	Single safety driver may only operate controls once stopped

**2. A description of Safety Driver qualifications established by the Tester.**

Argo safety drivers operating an AV as a single safety driver are selected from our highly-trained and experienced team of vehicle operators. All single safety drivers have an extensive body of experience and comprehensive training in addition to successful completion of Argo’s standard four-week safety driver training program. In addition to the foregoing, the selected single safety drivers also:

- have successfully completed all aspects of Argo’s Certified Autonomous Vehicle Operator Training Certification;
- have a minimum of 200 hours of total AV operating experience;
- have a minimum of 100 hours of AV public-road operating experience; and
- comply with all driver record requirements mandatory for single safety drivers as detailed in PennDOT’s Automated Vehicle Testing Guidance.

**3. Safety Case(s) for specific situations within the Operational Design Domain (“ODD”).**

In the following prescribed situations (which are described in more detail below), a single safety driver operates the AV within Argo’s ODD:

- testing within an active work zone;
- testing within an active school zone;
- testing within an emergency response area; and
- testing around Vulnerable Road Users (VRUs).

However, for any testing on snow-covered trafficways and testing within tunnels that may fall within Argo’s ODD, the single safety driver disengages the ADS by policy.

Before new software is rolled out to our public road test fleet, it passes through Argo’s four-part release candidate testing process, which consists of two types of virtual testing, known as simulation and resimulation, closed course testing, and testing on public roads. This process ensures that new software configurations perform as expected and validates that the system is safe for any given application within Argo’s ODD.

**1) Simulation**

- a) During the first stage the code is tested in simulation through two types of tests: broad simulation-based testing and resimulation of in-vehicle logs against new software changes.
- b) During broad simulation-based testing, scenarios are designed and tested in the virtual environment for each of the prescribed categories within Argo's ODD. This environment focuses on validating the control and planning portion of the ADS.

## 2) Resimulation

- a) The second stage consists of the resimulation testing method that uses real world data and data from structured tests at Argo's closed course track to validate that there are no regressions in the new software. This environment focuses on validating the control, planning, and perception portion of the ADS.

## 3) Closed Course Testing

- a) At the third stage, Argo performs release candidate testing at its closed course track involving driving routes and scenarios that simulate both common and unusual interactions anticipated to occur within the prescribed scenarios. This test method identifies specific interactions from the real world and edge cases to run through at the closed course track.
- b) Specific Safety Cases covered by the above testing include:
  - i) Testing within an Active Work Zone
    - (1) Construction zones are set up at the closed course track to allow the AV to drive through, identify, and react to construction objects. Structured tests are also designed to make the construction areas more complex during various testing scenarios.
  - ii) Testing within an Active School Zone
    - (1) Multiple active school zones are set up and marked at the closed course track so there is always an active and inactive school zone. AVs are always able to drive through these school zones when it is called for in the test plan.
  - iii) Testing within an Emergency Response Area
    - (1) Argo acquired an emergency vehicle light bar from a local police department for track testing of emergency response areas. The light bar is able to be moved between vehicle types to simulate various real world scenarios and situations.
  - iv) Testing around VRUs
    - (1) VRUs and VRU proxies are used in combination for daily and structured track testing. Areas in each operational city are also identified and used to test in real world situations.

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**4) Public Road Testing**

- a) At the fourth and final stage, Argo then takes that release candidate out for limited public road testing, still under test-engineering control, and drives predetermined routes to again test all necessary functionality. Argo then analyzes all of that data, and once that release candidate has been approved, the software is promoted for use by the test fleet.
- b) Areas in each operational city have been identified as good areas for data collection and public road testing for each of the prescribed scenarios. These areas help to validate new software changes in a real world environment.

**4. A description of any enhanced driver training beyond what is outlined in Section 7. (The Tester shall provide an outline of the training curriculum, a description of what is required to “pass,” and a description of the qualifications of the individual(s) overseeing the training.)**

Please see Argo’s Single Safety Driver Operations Supplemental Training (attached hereto).

**5. A description of auditing procedures implemented by the Tester.**

Argo’s Internal Audit Team will oversee audits of the SSD-TP. The Internal Audit Team’s purpose is to provide independent, objective assurance and consulting services designed to add value and improve the organization's operations in accordance with the Institute of Internal Auditors' mandatory guidance, including the Definition of Internal Auditing, the Code of Ethics, and the International Standards for the Professional Practice of Internal Auditing.

To protect the independence of the Internal Audit team, its personnel report to the Director of Audit. Currently, the Director of Audit reports directly to the Executive Vice President, General Counsel, Chief Compliance Officer. Upon the establishment of an independent Board of Directors and Audit Committee, the Director of Audit will report functionally to the Board and administratively (i.e., day to day operations) to the Executive Vice President, General Counsel, Chief Compliance Officer. Internal Auditors have no direct operational responsibility or authority over any of the activities audited. Accordingly, they will not implement internal controls, develop procedures, install systems, prepare records, or engage in any other activity that may impair an internal auditor’s judgment.

Internal Audit will audit the single safety driver program at least annually as part of an internal audit plan submitted for approval to members of Argo’s senior management team. The internal audit plan will be developed based on prioritization of the audit universe, which will include Argo’s single safety driver program, using a risk-based methodology, accounting for input from senior management.

Audits over the single safety driver program will be conducted in a manner consistent with Argo’s Internal Audit Team regular practices. Audit procedures may include the following: interviews with management, trainers, and safety drivers; observation of the training program;

and inspection of applicable documentation such as training decks and operations procedures. Areas of focus will include operational modifications arising from the single safety driver program.

**6. A description of the applicable performance and conformance monitoring metrics.**

The AV is equipped with a driver monitoring system that continuously monitors driver attentiveness and fatigue. The detection mechanism relies on infrared video sensors to track eye movement of the single safety driver in various lighting conditions and is configured to provide feedback based on where the single safety driver is looking inside and outside of the vehicle. This system is coupled with a cloud-connected video dashcam recording inside and outside the AV for test managers to monitor and escalate incidents or identify coachable driving patterns.

If the single safety driver's attention is not properly focused (e.g., not looking straight ahead, not looking at the single safety driver visualization system), an alarm is triggered in the vehicle to alert the driver, and the event is recorded for additional review and evaluation. Argo has three levels of driver monitoring alerts. If the single safety driver immediately refocuses their attention after the initial alarm, it is categorized as a level one alert. If the single safety driver does not immediately refocus their attention, a second alert is triggered, known as a level two alert. If the single safety driver does not respond to either the level one or level two alerts, a third alarm is triggered, known as a level three alert. All driver monitoring alerts are triggered based on an inverse function of time and AV speed (i.e., the time gap between alerts increases at lower speeds and decreases at higher speeds). Overall, the average time between alerts is two seconds, and each subsequent alert increases in intensity.

Argo's remote monitoring team receives notification of all driver monitoring system alerts, reviews all corresponding video, and categorizes the alerts by severity level. Depending on the severity of the alert, the single safety driver may be given a remediation plan, including additional training, increased spot checks, and additional driving evaluations. Termination of employment may result from failure to complete assigned remediation plans, a history of poor performance, or in some cases, a single instance of distracted driving.

Argo records metrics based on frequency and severity of driver monitoring system alerts to evaluate safe driving behavior and the efficacy of the driver monitoring system. Argo will report to PennDOT aggregated metrics for all level two and level three alerts, which will be represented as the number of autonomous miles driven per alert, for all autonomous miles driven with a single safety driver.

A secondary alert system, Driver Alert, is integrated into the ADS to predict potential traffic light and stop sign violations before they happen, alerting the single safety driver with an audible sound. Driver Alert also notifies the single safety driver if they are making a move that is counter to the map (e.g., a wrong turn into a one-way road).

# ARGO AI

## Single Safety Driver Operations Supplemental Training



# SINGLE SAFETY DRIVER OPERATIONS SUPPLEMENTAL TRAINING

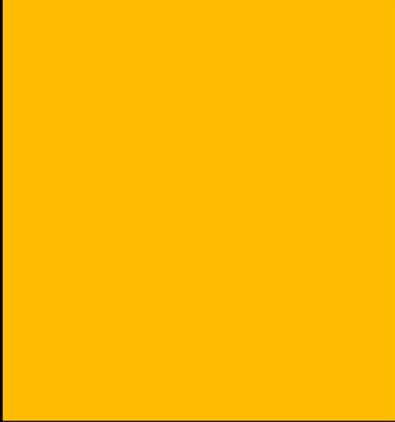
Argo AI (“Argo”) is building self-driving technology to make transportation safer, more affordable, and more accessible for all. Argo’s commitment to developing a safe self-driving system (“SDS”) begins with its approach to selecting its safety drivers and supporting their training and ongoing development to become Certified Autonomous Vehicle Operators (“CAVOs” or “Vehicle Operators”).

Part of this ongoing development includes training highly-skilled and experienced Vehicle Operators to operate an Argo Autonomous Vehicle (“AV”) as a single safety driver (“Single Driver”). During this training, all Vehicle Operators will be accompanied by another Vehicle Operator in the right seat (“Secondary Safety Associate”) during at least their first 200 hours of AV operation prior to beginning Single Driver operations. In addition, a minimum of 100 of those hours will occur on public roads. Fundamentals of Single Driver operations also require a modification of operating procedures from standard operations with two safety drivers.

Supplemental Single Driver training will require classroom learning and public road operations in the Single Driver configuration. During this time, the trainee will be expected to meet all minimum Argo standards for a minimum of three consecutive operational days without falling below standard in any category.

<b>[Supplemental Training]: Single Driver Operations</b>	
<b>Overview</b>	<ul style="list-style-type: none"> <li>● Training will focus on gaining familiarity and demonstrating expertise with the Single Driver SDS configuration and operating procedures.</li> <li>● Vehicle Operators will maintain attentiveness through monitored Single Driver commentary driving, a driver monitoring system that engages with the SDS, and fatigue management during all Single Driver training.</li> <li>● Public road observation will last for a minimum of three days and up to a maximum of five days, and will focus on ensuring that Argo standards are met during all Single Driver operations.</li> </ul>
	<ul style="list-style-type: none"> <li>● Demonstrate knowledge of the Single Driver SDS</li> </ul>

<p><b>Objectives</b></p>	<p>configuration and procedures.</p> <ul style="list-style-type: none"> <li>● React appropriately to alerts from the driver monitoring system in various situations.</li> <li>● Demonstrate safe public road Single Driver operations by meeting Argo standards in: <ul style="list-style-type: none"> <li>○ Attentiveness/360° awareness;</li> <li>○ Commentary driving; and</li> <li>○ Event logging.</li> </ul> </li> <li>● Demonstrate knowledge of proper incident response procedures during Single Driver scenarios.</li> </ul>
<p><b>Assessment/Evaluation</b></p>	<ul style="list-style-type: none"> <li>● Daily observation of the trainee is scored against a rubric that assesses their performance in attentiveness, 360° awareness, system awareness, Single Driver commentary, event logging, and ability to focus on the driving task.</li> <li>● To pass the Single Driver training program, the trainee must demonstrate proficiency in Single Driver operational standards for three consecutive days. The program is limited to a maximum duration of five days.</li> <li>● The trainee will fail a day of training if they do not meet minimum Argo performance standards, including: <ul style="list-style-type: none"> <li>○ Not responding appropriately to driver monitoring system alerts;</li> <li>○ Violating a road law during manual operations;</li> <li>○ Allowing the AV to violate a road law during autonomous operations; and</li> <li>○ Being involved in an at-fault collision.</li> </ul> </li> <li>● Road law violations and collisions will also be evaluated with respect to a trainee’s eligibility to continue operations with two Vehicle Operators and could lead to discipline or dismissal.</li> <li>● Trainees who are unable to pass the Single Driver training program may return to operations with two Vehicle Operators with increased frequency in</li> </ul>



spot checks by their manager.

- Trainees who fail the Single Driver training program must also wait a minimum of 60 days before they are permitted to attempt to pass the training again.
- Successfully passing this supplemental training certifies that the Vehicle Operator has the ability to safely operate Argo AVs on public roads in the Single Driver configuration.

## **SINGLE DRIVER OPERATIONS INITIAL CERTIFICATION TRAINING ADJUSTMENT**

Argo recognizes that future Vehicle Operators will be hired and trained to perform Single Driver operations from their initial date of employment. Operational changes for Single Driver will be integrated into Argo's four-week Certified Autonomous Vehicle Operator Training Certification program. A trainer will accompany the new Vehicle Operator for the initial four weeks of training and hours of operation will be logged against the 200-hour requirement for Single Driver. Trainees will be expected to meet all minimum Argo standards and complete coursework and examinations to earn certification. Paired operations in the Single Driver configuration will continue until the 200-hour requirement is met, at which time the Vehicle Operator may be certified for Single Driver.

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November 17, 2021

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The attached SSD-TP Supplemental Information contains Argo’s internal processes, testing procedures, and operational design domain parameters, which constitutes or reveals “Trade Secrets” as defined within 65 P.S. §67.102, and constitutes or reveals confidential proprietary information. Therefore, the information included in the SSD-TP Supplemental Information is exempt from access by a requester pursuant to 65 P.S. §67.708(b)(11). Argo is entitled to notice of a request for the SSD-TP Supplemental Information and an opportunity to respond under the procedure set forth in 65 P.S. §67.707(b).

If you have any additional questions or concerns please contact us via email at [REDACTED]

Sincerely,

Argo AI, LLC

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# Fleet Operations Training Team Overview

## General

- The Argo Fleet Operations training team is responsible for the education and training of all vehicle practices at Argo. The training team uses a defined set of operating standards to objectively measure a person's ability to perform the role of a Certified Autonomous Vehicle Operator (CAVO). The training team continuously evaluates new mission critical skills that were not defined at the time of the CAVO's initial training to match software progression and ODD expansion. Additional training is then conducted to ensure safety and compliance with new features and procedures.

## Team Size

- There are currently more than 25 members of the training team throughout all of Argo's operational locations. These numbers are expected to increase to meet the demands of our growing fleet and accommodate the need for more specialized skills and different mission types as they develop.

## Selection

- Individuals must apply for any position on the training team and only CAVO's in good standing are considered for a position on the training team. All applicants must pass through a technical screening and full panel interview before being selected to join the training team. Each member of the training team must maintain active CAVO status by operating and completing all annual certification requirements.
- Training Positions include:
  - **Training Associate:** Demonstrates solid understanding of instruction and coaching techniques, may even instruct classroom portions of training, including the management of activities and assignments.
  - **Training Manager I:** Subject matter expert who facilitates all phases of CAVO training as well as continuous education modules.
  - **Training Manager II:** Subject matter expert in all training modules and facilitation/leadership skills with an ability to train members of the training staff as a "Training Mentor."

## Training the Trainer

- Each member of the training team must complete a variety of coursework and materials related to their job expectations. An apprenticeship of in-vehicle coaching lasting 30 days is also observed during the initial training. The topics covered include but are not limited to:
  - Capturing Comprehension: The Role of Assessment



- Instructional and Communication Resources
- How Coaching and Mentoring Impact Learning
- The Communicative Environment: Setting the Stage for Active and Functional Communication
- Documenting and Evaluating Progress: Authentic Assessment for Adult Learners
- What is Meant by “Continuous Learning?” The Role of Training Managers in Relation to Fleet Professional Growth and Development
- The Relationship between Training and the Argo “Safety-First Mindset”
- New Feature Functionality and Deployment of New Trainings

**Oversight**

- Performance of the training program is under continual evaluation. While many aspects of the process overlap, oversight of the team is broken down into three main categories: (1) evaluation of the training associate role, (2) evaluation of the training manager, and (3) evaluation of the overall program performance.
  - Evaluation of the Training Associate Role
    - Weekly in-car observations by managers
    - Review of dash cam footage
    - Formal bi-monthly review of overall performance
  - Evaluation of the Training Manager
    - Continual review of the adherence to standards and best practices
      - Associate management
      - Adherence to programs and schedules
      - Leadership and cross functional collaboration
    - Formal quarterly evaluation of performance

<b>Quarter</b>	<b>Spot Check Format</b>	<b>Recommended Area of Focus</b>
Quarter 1 (Jan - Mar)	Instruction (Coursework/Content Review)	Training Program Management & Communication
Quarter 2 (Apr - June)	Coaching (In-Vehicle)	Feedback Provision; Communication
Quarter 3 (July - Sept.)	Instruction (Coursework/Content Review)	Assessment; Activities
Quarter 4 (Oct - Dec)	Coaching (Written)	Feedback Provision (written); Coaching-Instructional Connection

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- Evaluation of the Overall Program Performance
    - Curriculum Review
      - Continually updated and reviewed based upon:
        - Updated software releases
        - New feature capabilities
        - Expansion of ODD
        - Vehicle platform change
        - Updating of policy or process
    - Program Review
      - Bi-annual end-to-end review of the training team's effectiveness and overall impact on the organization.
      - Location-specific pass/fail rates and improvement to meet fleet standards.
      - Overall pass/fail rates and improvement to meet fleet standards
      - Auditing of all certifications and renewal dates to comply with internal requirements as well as regional and state regulations.