Trucking Fleet Concept of Operations for Automated Driving System-equipped Commercial Motor Vehicles

Chapter 5.3 ADS Inspection Procedure

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Abstract

Automated Driving Systems (ADS) are set to revolutionize the transportation system. In this project, the research team led by the Virginia Tech Transportation Institute developed and documented a concept of operations (CONOPS) that informs the trucking industry, government agencies, and non-government associations on the benefits of ADS and the best practices for implementing this technology into fleet operations.

The sections of Chapter 5 provide guidance on a range of topics for fleets to consider and apply when preparing to deploy ADS-equipped CMVs in their fleet. The topics cover fleet-derived specifications, ADS installation and maintenance, ADS inspection procedures, driver-monitor alertness management, insuring ADS-equipped trucks, identification of ADS safety metrics/variables, ADS road assessment, and data security/transfer protocol and cybersecurity best practices.

The development of vehicle automation and ADS show potential for significant safety improvements in CMV operations. However, there will be a need to inspect the vehicle and its systems that operate without a driver onboard to ensure proper performance and safety. This creates a challenge for the Federal Motor Carrier Safety Administration (FMCSA) and the CVSA to create policy and inspection procedures to ensure the safety of both CMVs and the motoring public. VTTI reviewed the Federal Motor Carrier Safety Regulations (FMCSRs) and the existing research literature to better understand the current state of practice regarding truck inspections and the implications of driverless vehicles. In conducting the literature review, the study team searched various terms related to truck inspections—roadside, pre-trip, Driver Vehicle Inspection Report (DVIR), periodic, and the link between mechanical failures and truck crashes. Additionally, the VTTI study team interviewed nine experts involved in motor carrier enforcement, motor carrier safety, and ADS technology development to better understand the challenges that ADS-equipped vehicles pose to existing truck inspection processes, to identify the changes needed in the FMCSRs, and to identify alternative truck inspection procedures. The section also provides insights into the enhanced CMV Inspection Program by CVSA specifically for ADS-equipped trucks. Lastly, recommendations, next steps, and future areas to consider are highlighted.

This report may be useful to fleets and drivers, policy- and decision-makers, ADS developers and original equipment manufacturers (OEMs), and law enforcement as they seek to understand the opportunities and challenges inspecting and ensuring a high level of equipment maintenance and repair for ADS-equipped trucks.

The following chapter has been extracted from the final report. For access to the full report, see this link: https://www.vtti.vt.edu/PDFs/conops/VTTI_ADS-Trucking_CONOPS_Final-Report.pdf

5. GUIDELINES

5.3 ADS INSPECTION PROCEDURE

5.3.1 Background

FMCSA is charged with the responsibility of reducing "crashes, injuries, and fatalities involving large trucks and buses."[1] To accomplish this safety mission, FMCSA establishes and enforces the FMCSRs. Truck inspections are a key element of Federal and State commercial vehicle safety programs. They are designed to ensure compliance with Federal and State safety, credentialing, and administrative (e.g., weight) regulations.

The FMCSRs require various types of inspections of commercial vehicles (large trucks, commercial buses, and hazardous materials vehicles).[2] Each commercial vehicle must be inspected at the beginning of the work shift. The driver is responsible for conducting this pre-trip inspection to ensure that major vehicle components are in good condition, and that the vehicle can be operated safely. Also, the driver, who has experienced the vehicle's handling, sounds, scents, and viewed the status of dashboard indicators, is in the best position to assess major vehicle components at the end of a work shift. Therefore, the driver has the responsibility for completing the DVIR at the end of the work shift. The motor carrier is responsible for complying with the FMCSR requirements for a periodic inspection. The motor carrier or third party is also responsible for a more thorough annual or periodic inspection.

Additionally, FMCSA provides support to its State partners to conduct roadside inspections of elements called out in the FMCSRs. FMCSA's State partners, located on major highways, conduct roadside inspections at fixed or mobile facilities. Roadside inspections focus on driver or vehicle inspection elements and are typically conducted when the commercial vehicle is en route to its destination. Violations found during a roadside inspection fall into two categories: (1) non-critical defects and (2) out-of-service (OOS). Typically, non-critical defects are those that pose little to no safety risk, and the commercial vehicle can return to the road even before the violation has been corrected. OOS violations, on the other hand, must be corrected before a commercial vehicle can return to service. OOS orders ensure that a commercial vehicle and/or its driver cannot proceed on the road until the conditions are corrected and the vehicle is safe to operate.

FMCSA has established several tools to support its enforcement efforts, including the Compliance, Safety, Accountability (CSA) Program and the Safety Measurement System (SMS). SMS ranks motor carriers based on their safety performance. The ranking is based on a function of data collected during roadside inspections (e.g., the frequency of different types of violations and the frequency of crashes that a carrier has had). The SMS was developed to prioritize unsafe, high-risk motor carriers for targeted interventions.

5.3.1.1 Problem

The development of vehicle automation and ADS provide tremendous potential for significant safety improvements. However, there will be a need to inspect the vehicle and its systems that operate without a driver onboard to ensure proper performance and safety. This creates a

challenge for NHTSA, FMCSA, and the CVSA to create policy and inspection procedures to ensure the safety of both CMVs and the motoring public.

Except for ADS components and software, the FMCSRs regarding the various requirements for truck inspections can continue without modification as long as a driver or safety operator is present. Once trucks are operating at SAE Level 4 and above, without a driver or safety operator, there is a need to modify the procedures that account for tasks that the driver and roadside inspector would normally be responsible for during each of the required truck inspections.

5.3.2 Literature Review

VTTI reviewed the FMCSRs and the existing research literature to better understand the current state of practice regarding truck inspections and the implications of driverless vehicles. Additionally, the VTTI study team interviewed nine experts involved in motor carrier enforcement, motor carrier safety, and ADS technology development to better understand the challenges that ADS-equipped vehicles pose to existing truck inspection processes, to identify the changes needed in the FMCSRs, and to identify alternative truck inspection procedures. This section summarizes findings from the literature review.

In conducting the literature review, the study team searched various terms related to truck inspections—roadside, pre-trip, DVIR, periodic, and the link between mechanical failures and truck crashes. While there is considerable research that supports the connection between truck mechanical failures and crashes and the impact of roadside inspections, the study team found only one study regarding the impact of periodic inspections and the two driver inspections (pre-trip and post-trip with DVIR).

5.3.2.1 Mechanical Failures and Truck Crashes

There have been many different approaches to studying the impact of mechanical failures and whether they contribute to truck crashes. Most seem to underreport the problem. Some of the early research (dating back to 1976) has suggested that mechanical failures in trucks are rare, as are failures in environmental components, such as the road system.[(3)]

In a 1989 study, researchers from the IIHS investigated the role of defective equipment in large truck crashes in a case-control study design. They found that 77% of tractor-trailers in crashes and 66% of those not involved in crashes had defective equipment warranting a citation. Brake defects were the most common type, found in 56% of tractor-trailers in crashes, followed by steering equipment defects (found in 21% of tractor-trailers in crashes).[(4)]

In a 1996 analysis of national crash data, researchers found very low rates of reported mechanical defects. For instance, only 2.8% of the trucks involved in crashes had mechanical defects. Of the defects noted, brakes were the most frequent, followed by wheels and tires, and steering.[(5)] Among fatal crashes, the authors found that brake defects were recorded for only 2%–3% of cases. The authors noted that “one obstacle in assessing the role of vehicle defects in accidents is the lack of systematic, post-collision vehicle inspections.” They concluded that reported vehicle defects were low and that it was difficult to determine whether this was due to the rarity of defects themselves or underreporting.

Some researchers have analyzed Police Accident Reports (PARs) to determine how frequently mechanical factors were cited. In a 1998 study that used this approach, researchers found that brake malfunctions were most frequently cited but were only found in 1.7% of crash involvements. Other cited defects related to tires, wheels, coupling, and load securement, all cited in about 0.4% of crashes.[6]

Other research approaches tend to find higher rates of vehicle defects. Researchers in Quebec used a case-control approach to study mechanical failures and truck crashes.[7] Their study team included three mechanical engineers who were trained in crash investigations. This team evaluated each crash and classified the crashes according to the role of mechanical defects. They found that only 11% of the trucks had no defects, 49.2% had minor defects, and 39.5% had serious defects. They found that heavy-vehicle mechanical condition was responsible for 10%–20% of crashes in Quebec. Like many other studies, they found that the most common defects related to truck brakes, followed by defects related to tires, chassis, and steering systems.

Because of the lack of consistency in research findings regarding the impact of mechanical failures on CMV crashes, Congress provided funding through the Motor Carrier Safety Improvement Act of 1999 to conduct a Large Truck Crash Causation Study (LTCCS) to determine contributing factors and causes of crashes involving CMVs. From 2001 to 2003, FMCSA collected a nationally representative sample of large-truck fatal and injury crashes at 24 sites in 17 States. FMCSA collected up to 1,000 data elements on each crash. The total sample involved 967 crashes, which included 1,127 large trucks, 959 non-truck motor vehicles, 251 fatalities, and 1,408 injuries. This was, by all accounts, the largest study ever conducted on commercial vehicle crashes. FMCSA concluded that 87% of crash involvements were related to driver error, followed by vehicle factors at slightly over 10%, and environmental and other factors at approximately 3%.[8]

The lack of consistency in the research regarding mechanical failure and truck crashes is primarily due to the evaluation methods used. PARs—and the national databases that are informed by PARs—tend to underreport the impact of mechanical failures on crashes. Studies with professionals trained to evaluate mechanical defects tend to suggest that the impact of mechanical failures is much more significant.[9,10,11] The Quebec study[12] and the landmark LTCCS[13] found that mechanical failure is a contributing factor in at least 10% of truck crashes.

5.3.2.2 Research on Roadside Inspections

To help achieve the Agency's safety mission of reducing crashes involving CMVs, FMCSA provides support for States to perform roadside inspections of large trucks, commercial buses, and hazardous materials vehicles.[14] Roadside inspections are typically conducted at fixed and mobile sites located along major highways when a CMV is traveling to its destination. There are multiple levels of inspections, which focus on the driver, the vehicle, or both.

Violations found during roadside inspections fall into two categories: (1) non-critical defects and (2) OOS. Typically, non-critical defects pose little to no safety risk. When issued a violation for a non-critical defect, the commercial vehicle can return to the road before the violation has been corrected. OOS violations, however, indicate a safety risk. OOS violations must be corrected before a commercial vehicle or driver can return to service. OOS orders can decrease the

incidence of crashes caused by mechanical defects and/or problems with driver credentials or HOS.[15]

Roadside inspections also inform other FMCSA enforcement initiatives, including the CSA program and the SMS. The SMS ranks motor carriers based on their safety performance, which is informed by data collected during roadside inspections (e.g., the frequency of different types of violations and the frequency of crashes that a carrier has had). The SMS was developed to prioritize unsafe, high-risk motor carriers for targeted interventions. Many researchers have found that roadside inspections are useful to remove unsafe commercial vehicles from the highway and have helped reduce commercial vehicle crash rates. [16, 17, 18, 19, 20, 21]

5.3.2.3 Research on Periodic Inspections

The main objective of FMCSA's periodic inspection requirement (49 CFR section 396.9) is to help ensure that the mechanical condition of certain vehicle components is acceptable. The concern is that without such a program, as vehicles get older and acquire greater mileage and wear and tear, their mechanical condition will deteriorate, and the risk of crashes caused by mechanical defects will increase. However, research results on the efficacy of periodic inspections of all vehicles are mixed, and the study team was only able to find one research study that examined periodic inspections of commercial vehicles.

In a 1999 study of the effects of commercial vehicle mechanical condition on road safety in Quebec, researchers found that Quebec's Mandatory Mechanical Inspection Program (MMIP) was not achieving its stated objective of keeping vehicles with the potential for mechanical failure—particularly vehicles greater than 10 years old—off the road. If the older vehicles were removed, then there was evidence that the MMIP did help to identify vehicles that had mechanical failures. However, the effectiveness of the periodic inspections for newer vehicles lasted for only 3 months. Brakes need to be checked more frequently than annually. The study concluded the whole inspection regimen—including pre-trip inspection and frequent roadside inspections—should help keep noncompliant vehicles off the roads. The authors suggested that drivers should be better trained on how to conduct inspections and should use visual indicators to verify the adjustment of brake-cylinder push rods.[22]

The study team also reviewed the research on light vehicles. It is important to note that there are considerable differences between light and heavy vehicles regarding miles traveled per year. In 2019, the FHWA determined that the average light duty vehicle travels **11,500 miles** per year, whereas the average combination truck travels 59,900 miles per year.[23] Some researchers have shown that periodic inspections have positive safety impacts, while others have not found safety benefits. A 1982 study showed that random safety inspections were as effective as periodic inspections in preventing crashes and deaths.[24]

A 1985 study that applied an econometric model to data from New Jersey determined that the State's inspection program had positive safety effectiveness in terms of reducing fatalities and injuries.[25] In another study, researchers found that States with a vehicle safety inspection program can prevent one to two safety-related fatalities per billion vehicle miles traveled, when compared to States without such a program.[26] This study projected that Pennsylvania would experience 127 to 187 fewer fatalities each year because of its inspection program. Another

study that evaluated Pennsylvania vehicle safety inspection data from 2008 to 2012 found that the State safety inspection failure rate for passenger vehicles was 12%–18%.[27]

In a 2008 study, researchers compared crash data from Nebraska before and after the discontinuation of the State safety inspection program and concluded that the program did not reduce fatalities.[28] Similarly, a 1994 study on vehicle safety inspection laws and highway facilities[29] and a 1999 study on the effectiveness of safety inspections[30] found no evidence that inspections significantly reduce fatality or injury rates. A 2002 study found that inspections had no significant impact on the number of older cars on the road.[31] Another study published in 2013 showed that periodic safety inspections can bring some safety benefits, but more frequent inspections (more than once per year) are not justified.[32] Finally, in a 2018 study that utilized a synthetic controls approach to examine traffic fatality data from 2000 to 2015 in New Jersey (which ended safety inspection requirements in 2010), researchers concluded that ending the mandatory inspection program did not result in a significant increase in the frequency or intensity of crashes resulting from car failure.[33]

5.3.2.4 Summary of Review Findings

Research on the effects of roadside inspections has shown a strong relationship between quality maintenance and inspection procedures and a decline in crashes related to vehicle defects. Mechanical failures appear to be a contributing factor in at least 10% of truck crashes. Failures most likely to cause crashes were those associated with brakes, tires/wheels, and lights. Additionally, research has found that roadside inspections and application of the OOS criteria have significantly decreased the rate of truck crashes in which mechanical or safety defects were cited as a primary contributing factor. The efficacy of the periodic annual inspection is more uncertain. One study of CMVs suggested that the annual inspection was important with older vehicles and for identification of vehicles that were likely to have mechanical failures. This research suggested the need for more frequent inspections and that the frequency of the periodic inspection needed to be increased, particularly for those systems (brakes, tires/wheels, and lights) that are more likely to contribute to crashes.

5.3.2.5 Summary of the ADS Enhanced CMV Inspection Program Documentation

The CVSA Enhanced Commercial Motor Vehicle Inspection Standard (for motor carrier operations) December 2022 Edition is a comprehensive book detailing all the requirements for the inspection, including illustrations and diagrams as well as checklists and charts. It includes sections on inspection procedures, cargo securement, operational policies, inspection bulletins, training aids, and the inspection standard.

Also available is the CVSA Enhanced Commercial Motor Vehicle Inspection (for motor carrier operations) Course Participant Manual December 2022 Edition. This abbreviated manual is for classroom use and includes worksheets. The sections of the inspection are broken down into categories, including introduction, initial tractor inspection, mid-section inspection, trailer and wheel inspection, subsequent tractor inspection, axle inspection, brake inspection, and tractor interior inspection. This book is designed to be used during training and retained by the trainee after the course. Both resources are available in print and electronic form.

5.3.3 Existing Truck Inspection Requirements

ADS-equipped trucks may be subject to different types of inspection requirements than existing, non-ADS trucks. There are five existing truck inspection requirements:

1. Pre-trip Inspection
1. DVIR
2. Roadside Inspection/Post-crash Inspection
3. Periodic Inspection – Annual Maintenance
4. Law Enforcement Stops – Safety Inspections

Table 20 summarizes key characteristics of each type of inspection requirement (e.g., frequency, who conducts the work, and elements inspected).

Table 1. Inspection requirements for CMVs.

Truck Inspection Requirements	Pre-trip Inspection	Roadside Inspection/Post-Crash Inspection (Fixed & Mobile Sites)	DVIR	Periodic Inspection: Annual Maintenance	Law Enforcement Safety Inspections
Frequency	Daily	Possibly Daily	Daily	Annual	Infrequent
Conducted by:	Driver	State Inspector	Driver	Motor Carrier or Third-party Maintenance	Law Enforcement
Special Credentials	CDL holder	FMCSA/CVSA-trained	CDL holder	Experience, training, or both	
Inspection Elements	Pre-trip inspection to ensure that all DVIR elements are functioning correctly.	Thorough inspection of the DVIR elements: • Suspension • Open-top trailer and van bodies • Emergency exit • Driveshaft • Cargo securement • Hazardous materials and cargo tank driver inspection items	Minimum Elements 1. Service brakes and connections 2. Parking brake 3. Steering mechanism 4. Lights and reflectors 5. Tires 6. Horn 7. Windshield wipers 8. Rear vision mirrors 9. Coupling devices 10. Wheels and rims 11. Emergency equipment	• Inspect for defects • Brakes • Coupling devices • Exhaust system • Fuel system • Lighting device • Safe loading • Steering, suspension, and frame • Tires, wheels, and rims • Windshield glazing and wipers • Driver seat	Ad hoc safety inspection

5.3.3.1 Pre-trip Inspections

The primary goal of the pre-trip inspection is to ensure that all vehicle components are in good working order. As shown in Table 20, the FMCSRs specify the minimum elements that drivers are required to inspect prior to beginning a trip. Some motor carriers may require drivers to inspect more elements than the minimum specified by FMCSA.

Summary of the Requirements – Pre-trip Inspections: Per 49 CFR 396.13, *Driver inspection*, before operating a CMV, a driver must inspect the vehicle and be satisfied that it is in safe operating condition. During the pre-trip inspection, the driver should check to ensure all the elements included in the DVIR are functioning properly. If the last vehicle inspection report notes any deficiencies, the driver must sign the report to acknowledge (1) that the driver has reviewed it, and (2) that there is a certification that the required repairs have been performed. The signature requirement does not apply to listed defects on a towed unit that is no longer part of the vehicle combination.

Pre-trip Inspection Considerations for ADS-equipped CMVs: As indicated above, 49 CFR 396.13 specifically requires the driver to complete a series of inspection tasks. Table 21 presents the challenges that 49 CFR 396.13 may pose to ADS-equipped vehicles, potential changes that may need to be applied to the regulation to enable safe deployment of ADS-equipped vehicles, and some potential pre-inspection alternatives.

Table 2. Summary of considerations around 49 CFR 396.13 (pre-trip inspection).

Challenges and Considerations for ADS-equipped Vehicles	FMCSR Changes and Considerations	Inspection Alternatives and Considerations
1. The driver is responsible for inspections, recognition, and decision-making tasks. 2. The pre-trip inspection itself is not a complex task; it is a series of go/no-go decisions.	1. The FMCSRs may require modification to allow carrier personnel (not necessarily drivers) to conduct inspections or to allow electronic checks of inspections elements. 2. Some inspection elements may need to be added or removed from the list of elements to be covered on the DVIR.	1. **Alternative Carrier Inspection.** Allowing other carrier personnel to conduct the pre-trip inspection. Are special credentials needed for "carrier inspectors"? 2. **Electronic Inspection.** What inspection elements can be conducted electronically? To whom should they be communicated? 3. **Hybrid Inspection.** Electronic and carrier check of inspection elements.

Expert Opinions on Pre-trip Inspections for ADS-equipped CMVs: Inspectors suggested that the pre-trip inspection is an important part of the overall truck inspection regime and, if done properly, it ensures that trucks on the roadway are mechanically fit for U.S. highways. There were some concerns raised that truck drivers may not be adequately trained to conduct a thorough inspection or that they do not take the time to do an adequate pre-trip inspection. Some were also concerned that electronic systems have made it too easy for drivers to sign-off that the

inspection was conducted. One inspector pointed out that he has put trucks OOS for inspection elements that were very visible and that should not have gone undetected. He also pointed out that, nationwide, roughly 20% of the trucks inspected at roadside are put OOS; if the pre-trip inspection was done properly, he felt that the percentage would not be that high.

The CVSA's recommended inspection protocol limits the roadside inspection of an ADS-equipped vehicle operating without a driver or safety operator to situations where an imminent hazard is observed or during a post-crash investigation. Rather, the protocol focuses on an origin/destination (terminal) inspection model, and the vehicle would be required to communicate to enforcement while in motion that it had passed the origin/destination inspection, that its ADS were functioning, and that it is operating within its ODD.

CVSA and ATA Recommendations: CVSA has made several recommendations for inspecting ADS-equipped vehicles that are operating at SAE Level 4 and above. CVSA and the American Trucking Associations (ATA) task force have both supported an enhanced pre-trip inspection model like the trip inspection outlined in the Canadian National Safety Code (NSC) #13. Members of the Canadian **Council of Motor Transport Administrators** (CCMTA), with the help of the motor carrier industry, developed a set of 16 safety standards. The goal of these standards was to improve highway safety and the efficient movement of people and goods across Canada. The NSC is somewhat like the U.S. FMCSRs in that it provides a general federal framework that each of the provinces and territories can adopt to regulate their motor carrier industry.

NCS #13 specifies a daily trip inspection. The goal of the daily trip inspection is to provide early detection of vehicle problems, malfunctions, and defects, thereby reducing the possibility of mechanical breakdown or collision. This is similar to the U.S. pre-trip inspection, but instead of prescribing only 11 DVIR inspection items, it requires the inspection of 23 items on the vehicle every 24 hours, as shown in Table 22. After the trip inspection is conducted, non-critical defects are noted on a report for the vehicle, and major issues need to be fixed by the motor carrier before the vehicle can be driven. An example of the U.S. DVIR is provided in Figure 42.[34]

Driver's Vehicle Inspection Report

Check ANY Defective Item and Give Details under "Remarks."

DATE: _____

TRUCK/TRACTOR NO. _____

- ❑ Air Compressor
- ❑ Air Lines
- ❑ Battery
- ❑ Brake Accessories
- ❑ Brakes
- ❑ Carburetor
- ❑ Clutch
- ❑ Defroster
- ❑ Drive Line
- ❑ Engine
- ❑ Fifth Wheel
- ❑ Front Axle
- ❑ Fuel Tanks
- ❑ Heater
- ❑ Horn
- ❑ Lights
  - Head – Stop
  - Tail – Dash
  - Turn Indicators
- ❑ Mirrors
- ❑ Muffler
- ❑ Oil Pressure
- ❑ On-Board Recorder
- ❑ Radiator
- ❑ Rear End
- ❑ Reflectors
- ❑ Safety Equipment
  - Fire Extinguisher
  - Flags – Flares – Fuses
  - Spare Bulbs & Fuses
  - Spare Seal Beam
- ❑ Springs
- ❑ Starter
- ❑ Steering
- ❑ Tachograph
- ❑ Tires
- ❑ Transmission
- ❑ Wheels
- ❑ Windows
- ❑ Windshield Wipers
- ❑ Other

TRAILER(S) NO (S). _____

- ❑ Brake Connections
- ❑ Brakes
- ❑ Coupling Chains
- ❑ Coupling (King) Pin
- ❑ Doors
- ❑ Hitch
- ❑ Landing Gear
- ❑ Lights – All
- ❑ Roof
- ❑ Springs
- ❑ Tarpaulin
- ❑ Tires
- ❑ Wheels
- ❑ Other

Remarks: _____

_____

_____

_____

_____

_____

_____

❑ Condition of the above vehicle is satisfactory

Driver's Signature _____

❑ Above Defects Corrected

❑ Above Defects Need NOT Be Corrected For Safe Operation Of Vehicle

Mechanic's Signature _____ Date _____

Driver's Signature _____ Date _____

Figure 1. Illustration. U.S. DVIR.

Table 3. Comparison between U.S. pre-trip and Canadian trip inspection elements.

U.S. Pre-trip Inspection Items	Canadian Trip Inspection NSC#13
Service brakes and connections	Brake system defect(s)
Parking brake	
	Electric brake system defect(s)
	Hydraulic brake system defect(s)
Coupling devices	Coupling devices defect(s)
Emergency equipment	Emergency equipment & safety devices defect(s)
Rear vision mirrors	Glass and mirrors defect(s)
Horn	Horn defect(s) 1
Lights and reflectors	Lamps and reflectors defect(s)
Steering mechanism	Steering defect(s)
Tires	Tires defect(s)
Wheels and rims	Wheels, hubs and fasteners defect(s)
Windshield wipers	Windshield wiper/washer defect(s)
	Cab defect(s)
	Cargo securement defect(s)
	Dangerous goods major defect(s)
	Driver controls defect(s)
	Driver seat defect(s)
	Exhaust system defect(s)
	Frame and cargo body defect(s)
	Fuel system defect(s)
	General defect(s)
	Heater/defroster defect(s)
	Suspension system defect(s)

The team interviewed a CCMTA official who felt that the big difference between the U.S. and Canadian trip inspections was that NSC #13 specifies "Schedule 1," which clearly lays out defects that a driver is expected to find during their daily vehicle inspection. The schedule also indicates (1) that the non-critical defects that do not prohibit the vehicle from being driven provided they are recorded on the daily vehicle inspection report and (2) that the major defects have to be repaired before continuing.

Alongside enhanced pre-trip inspections, Level 4 and above ADS are expected to have access to self-diagnostic capabilities exceeding those of traditional trucks. In this scenario, if the ADS is unable to pass the self-diagnostics, then the ADS would not allow the system to be switched into automated driving mode.

Evidence suggests that the Canadian trip inspection identifies faults and defects more effectively than the U.S. pre-trip inspection. With the assistance of the Analysis Division of the FMCSA, the VTTI team obtained data on U.S. roadside inspections. Table 23 shows the results of three inspection types (vehicle, driver, and HAZMAT) for U.S.-domiciled motor carriers versus Canadian-domiciled motor carriers. The data is from FMCSA's Motor Carrier Management Information System (MCMIS) data snapshot as of May 28, 2021, including current year-to-date

information for fiscal year (FY) 2021. Of the three inspection types, vehicle OOS rates were considerably higher (nearly 10%) for U.S.- versus Canadian-domiciled carriers. The difference in OOS rates for driver and HAZMAT inspections was much smaller. Interviews with Canadian officials suggested that the Canadian regimen of inspections (daily and periodic) provides better detection of mechanical failures.

Table 4. OOS rates for U.S.- and Canadian-domiciled carriers.

	FY 2017		FY 2018		FY 2019		FY 2020		FY 2021	
Vehicle Inspections	Number of Inspections	OOS Rate	Number of Inspections	OOS Rate	Number of Inspections	OOS Rate	Number of Inspections	OOS Rate	Number of Inspections	OOS Rate
U.S.	1,988,450	21.6%	2,049,341	21.9%	2,042,419	21.7%	1,619,369	21.8%	1,107,030	22.0%
Canadian	46,531	12.4%	46,011	12.1%	45,643	11.4%	38,191	11.0%	29,844	12.1%
Difference		9.2%		9.8%		10.3%		10.8%		9.9%
Driver Inspections										
U.S.	2,927,147	5.5%	3,035,975	5.2%	3,000,996	5.4%	2,382,237	5.6%	1,621,217	6.0%
Canadian	83,760	3.3%	83,798	2.2%	85,086	2.1%	67,414	2.3%	50,555	2.1%
Difference		2.2%		2.9%		3.3%		3.3%		3.9%
HAZMAT Inspections										
U.S.	187,168	4.0%	188,565	4.2%	193,297	4.5%	144,439	4.6%	101,850	4.2%
Canadian	2,968	2.8%	2,799	3.0%	2,723	3.8%	2,001	3.9%	1,491	3.8%
Difference		1.2%		1.2%		0.8%		0.7%		0.5%

CCMTA officials felt that the difference between the U.S. and Canadian vehicle OOS rates was more likely due to the Canadian inspection regime as compared to the U.S. inspection regime. The Canadian inspection regime can include the daily trip inspection, which includes more inspection elements, and a periodic inspection that, depending on the province, can be required twice per year.

5.3.3.2 Post-trip Inspections–DVIR

In addition to a pre-trip inspection (required by 49 CFR 396.13), drivers are also required to conduct a post-trip inspection. The rationale for the post-trip inspection is that the driver, who has experienced the vehicle's handling, sounds, scents, and changes in various dashboard indicators, is in the best position to assess major vehicle components at the end of the work shift. Therefore, the driver is responsible for completing the DVIR at the end of the work shift.

Summary of the Requirements–Post-trip Inspection/DVIR: Per 49 CFR 396.11, "Every motor carrier shall require its drivers to report, and every driver shall prepare a report in writing at the completion of each day's work on each vehicle operated, except for intermodal equipment tendered by an intermodal equipment provider." Like the pre-trip inspection, the post-trip inspection must cover the following minimum elements:

- Service brakes including trailer brake connections
- Parking brake
- Steering mechanism
- Lighting devices and reflectors

- Tires
- Horn
- Windshield wipers
- Rear vision mirrors
- Coupling devices
- Wheels and rims
- Emergency equipment

A CMV driver is only required to prepare a post-inspection DVIR if the driver discovers a defect or deficiency during the inspection (or if a defect or deficiency is reported to the driver).[1] When a report is required, the report must identify the vehicle and list any defect or deficiency discovered by or reported to the driver that would affect the safe operation of the vehicle or result in a mechanical breakdown. If a driver operates more than one vehicle during the day, a report must be prepared for each vehicle operated. The driver is required to sign the report.

If a driver identifies and records defects or deficiencies during a post-crash inspection, the motor carrier or its agent must repair the listed defects or deficiencies before the driver operates the vehicle again. Once the repairs are completed, the motor carrier or agent must certify on the DVIR that the required repairs have been made (or that the repairs are not necessary before the vehicle is operated again). The motor carrier must maintain the DVIR, certification of repairs, and certification of the driver's review (at the next pre-trip inspection) for 3 months from the reporting date.

Drivers and/or motor carriers must also conduct post-trip inspections of any equipment provided by intermodal equipment providers (IEPs). Drivers and motor carriers must report to the IEP (or its designated agent) any known damage, defects, or deficiencies in the intermodal equipment at the time the equipment is returned to the IEP (or its designated agent). The report must include the following minimum parts and accessories:

- Brakes
- Lighting devices, lamps, markers, and conspicuity marking material
- Wheels, rims, lugs, tires
- Air line connections, hoses, and couplers
- King pin upper coupling device
- Rails or support frames
- Tie down bolsters
- Locking pins, clevises, clamps, or hooks
- Sliders or sliding frame lock

[1] Exception: drivers of for-hire passenger CMVs are required to prepare this report whether any defects/deficiencies are detected or not.

In addition to a description of the identified damage, defects, or deficiencies that would affect the safe operation of the intermodal equipment or cause its mechanical breakdown while in transport, the intermodal equipment report must include the name and USDOT number of the motor carrier responsible for operating the intermodal equipment at the time the issue(s) were identified. The report must also include the IEP's USDOT number and a unique identifying number for the item of intermodal equipment, the signature of the driver who prepared the report, and the date and time the report was submitted.

The IEP is responsible for repairing the reported damage, defects, or deficiencies on a piece of intermodal equipment before allowing the motor carrier to transport that piece of equipment again. The IEP or designated agent must certify on the original driver's report that the damage, defects, or deficiencies have been repaired (or that the repairs are not necessary before the equipment is operated again). For each intermodal equipment report, the IEP must maintain the original driver report and the certification of repairs for a period of 3 months from the date that a motor carrier or driver submits the original report to the IEP or its designated agent.

Post-trip Inspection/DVIR Considerations for ADS-equipped CMVs: Drivers play a significant role in post-trip inspections, not only in conducting the inspection itself, but also in preparing the DVIR and reviewing the motor carrier's certification that the necessary repairs were made prior to the next trip. Besides the pre-trip inspection, the post-trip inspection is the most driver-centric inspection requirement. Table 24 summarizes the challenges that existing post-inspection requirements may pose to ADS-equipped vehicles, along with potential changes that may need to be applied to the regulations to enable safe deployment of ADS-equipped vehicles. The table also outlines potential roadside inspection alternatives.

Table 5. Summary of considerations around 49 CFR 396.11 (post-trip inspections).

Challenges and Considerations for ADS-equipped Vehicles	FMCSR Changes and Considerations	Inspection Alternatives and Considerations
1. The driver is responsible for inspections, recognition, and decision-making tasks. 2. The post-trip inspection itself is not a complex task; it is a series of go/no-go decisions.	1. The FMCSRs may need to be modified to allow carrier personnel (not necessarily drivers) to conduct inspections or to allow electronic checks of inspection elements. 2. With ADS-equipped trucks that are likely dispatched upon arrival to a depot, the post-trip inspection may no longer be needed or practical (i.e., no need for two inspections on quick turnarounds). 3. Some inspection elements may need to be added or removed from the list of elements to be covered on the DVIR.	1. **Alternative Carrier Inspection.** Allowing other carrier personnel to conduct the post-trip inspection. Are special credentials needed for "carrier inspectors"? 2. **Electronic Inspection.** What inspection elements can be conducted electronically? To whom should they be communicated? 3. **Hybrid Inspection.** Electronic and carrier check of inspection elements. **4. Eliminate the Post-trip Inspection.**

The purpose of the post-trip inspection is to get driver input into the operations of the commercial vehicle. The driver has driven the vehicle for as long as 11 hours and should be aware of any vehicle components that appear to be malfunctioning. This provides a carrier with useful information on the repairs that may be needed prior to the start of the vehicle's next shift.

DVIR Considerations for ADS-equipped CMVs: Currently the DVIR is the responsibility of the driver. For scenarios in which a driver or safety operator is not required, the FMCSRs may need to be modified to allow carrier personnel (not necessarily drivers) to conduct inspections or to allow electronic checks of inspection elements. Additionally, ADS-equipped trucks will likely be highly utilized by motor carriers since they will no longer be constrained by HOS limitations. Therefore, they will likely be dispatched upon arrival to a depot or transfer station. The post-trip inspection may no longer be needed or practical, i.e., there may be no need for both pre- and post-trip inspections for quick turnarounds. Additionally, some inspection elements may need to be added or removed from the list of elements to be covered on the DVIR.

Expert Opinion Regarding the DVIR for ADS-equipped CMVs: The study team interviewed Federal and State officials, including CVSA inspectors. The consensus of this group was that the post-trip inspection would no longer be needed. Given the many possible utilization scenarios, this group felt that these vehicles will likely be highly used to increase vehicle productivity and that these vehicles will not be limited to the current driver's HOS constraints. Therefore, the inspectors that we interviewed felt that these vehicles would be dispatched in a way that would require quick turnarounds and that there is no need for both the pre-trip inspection and post-trip DVIR.

5.3.3.3 Roadside Inspections/Post-crash Inspections

Inspectors conducting roadside inspections are working to ensure that motor carriers operating on the Nation's roadways are adhering to the safety standards established by Congress and the USDOT. The purpose of the roadside inspection is to provide an unscheduled "spot check" examining a carrier's and driver's compliance.

Summary of the Requirements – Roadside Inspections: CMV roadside inspections are costly to conduct in terms of both time and human resources. A Level I inspection takes 30 minutes to an hour to complete, not including the amount of time trucks wait in the queue for a manual roadside inspection. Highly trained inspectors in each State inspect CMVs using inspection procedures developed by CVSA. These procedures and criteria are part of the North American Standard (NAS) Inspection Program and currently include eight levels of inspection, which are summarized in Table 25.

Table 6. CVSA levels of inspections and procedures.

Level	Description
Level I: NAS Inspection	An examination of the carrier's and driver's credentials, record of duty status (RODS), the mechanical condition of the vehicle, and any hazardous materials/dangerous goods that may be present.
Level II: Walk-Around Driver/Vehicle Inspection	A driver and walk-around vehicle inspection, involving the inspection of items that can be checked without physically getting under the vehicle.

Level	Description
Level III: Driver/Credential/ Administrative Inspection	A driver-only inspection that includes examination of the driver's credentials and documents.
Level IV: Special Inspections	Special inspections are a one-time examination of a particular item. These examinations are normally made in support of a study or to verify or refute a suspected trend.
Level V: Vehicle Only Inspection	A vehicle-only inspection, which may be performed without a driver present, at any location.
Level VI: NAS Inspection for Transuranic Waste and Highway Route Controlled Quantities of Radioactive Material	An inspection of transuranic waste and route-controlled quantities of radioactive material.
Level VII: Jurisdictional Mandated Commercial Vehicle Inspection	A jurisdictionally mandated inspection.
Level VIII: NAS Electronic Inspection	An inspection conducted electronically while the vehicle is in motion, without direct interaction. At the time of this report, this inspection is driver focused.

The Level I inspection—the most common and most comprehensive of all the inspection types—involves the examination of the driver's credentials and RODS along with a detailed inspection of the mechanical condition of the vehicle. It is a 37-step procedure that addresses the following items:

Vehicle:

- Suspension, tire, rim, hub, wheel assemblies
- Open-top trailer and van bodies
- Windshield wiper operations
- Emergency exit
- Steering mechanisms
- Driveline/driveshaft mechanisms
- Lightning device and coupling operations
- Cargo securement
- Hazardous material and cargo tank specification compliance
- Braking systems
- Electrical systems
- Exhaust system
- Fuel systems

Driver:

- Seatbelt usage

- Possible drug and alcohol usage
- Medical Examiner's Certificate
- Skill Performance Evaluation certificate
- Commercial Driver's License
- HOS or HOS compliance
- RODS or RODS compliance

Violations from these inspections are recorded in the MCMIS. FMCSA uses data in the MCMIS to identify carriers that are out of compliance with Federal regulations and good candidates for targeted safety interventions. The MCMIS contains carrier registration details, information from inspections and interventions, and violation and crash data. All these data is used in FMCSA's SMS.

One of the challenges in the United States with the existing roadside inspection program is that there are currently approximately 5 million CMVs, and only up to 3.5 million inspections are conducted each year. This means that a CMV could go several years without being inspected. Many carriers have complained that SMS does not contain enough inspection data to prioritize safety interventions. In addition, many large carriers participate in bypass programs and thus do not get credit for operating safe vehicles.

Per 49 CFR 396.9, *Inspection of motor vehicles and intermodal equipment in operation*, special agents of FMCSA are authorized to conduct inspections of a motor carrier's vehicles and/or intermodal equipment in operation. Inspectors use the Driver Vehicle Examination Report to record inspection results. Inspectors are responsible for declaring motor vehicles or intermodal equipment OOS if its mechanical condition would likely cause an accident or breakdown. Motor carriers, IEPs, and their staff (including drivers) are prohibited from operating OOS vehicles or equipment until all necessary repairs have been made. This includes towing the vehicle, except under certain circumstances (e.g., with a crane or hoist).

Inspectors provide a completed inspection report to the driver of any inspected motor vehicle (or vehicle transporting intermodal equipment). The driver is then required to deliver a copy of that report to the motor carrier (and if applicable, the IEP) upon arrival at the next terminal or facility. If the driver is not scheduled to arrive at the terminal or facility within the next 24 hours, the driver is required to mail, fax, or otherwise transmit the report to the motor carrier or IEP.

Upon receipt of the inspection report, motor carriers and IEPs are required to examine the report and correct any noted violations or defects, documenting repairs to OOS intermodal equipment in associated maintenance records. Within 15 days of the inspection, the motor carrier or IEP must (1) certify that all noted violations were corrected, and (2) return the completed roadside inspection form to the issuing agency. The motor carrier or IEP must also maintain a copy of the completed form for at least 1 year.

Roadside Inspection Considerations for ADS-equipped CMVs: As described above, several CVSA inspection levels (see Table 25) and 49 CFR 396.9, specifically, require the driver to interact with the inspector and complete a series of tasks. Table 26 summarizes the challenges

the existing requirements may pose to ADS-equipped vehicles, along with potential changes that may need to be applied to the regulation to enable safe deployment of ADS-equipped vehicles. The table also outlines potential roadside inspection alternatives.

Table 7. Summary of considerations around 49 CFR 396.9 and the existing CVSA inspection levels.

Challenges and Considerations for ADS-equipped Vehicles	FMCSR Changes and Considerations	Inspection Alternatives and Considerations
1. In a CVSA Level I, II, or III inspection, the driver must provide credentials and other information (e.g., RODS or HOS logs). 2. Per 49 CFR 396.9(d), any driver who receives an inspection report must subsequently deliver it to the motor carrier and/or IEP within 24 hours. 3. In a CVSA Level I, II, or V inspection, the inspector must examine a number of vehicle components, some of which may have different specifications in ADS-equipped vehicles (compared to non-ADS-equipped vehicles).	1. The FMCSRs may need to be modified to allow inspectors to transmit inspection reports directly to motor carriers or IEPs (instead of the driver delivering the report). 2. Some of CVSA's required inspection elements may need to be modified for Level I, II, and V inspections of ADS-equipped vehicles.	1. **Electronic Inspection.** What inspection elements can be conducted electronically? To whom should results be communicated? 2. **Hybrid Inspection.** Electronic and inspector check of inspection elements.

Expert Opinion Regarding Roadside Inspections of ADS-equipped CMVs: Inspectors were split on the idea of whether to conduct a Level 1 inspection at roadside or a Level 5 inspection at an alternative site (i.e., carrier's terminal or transfer center). The inspectors who felt it would be necessary to inspect vehicles roadside commented that ADS-equipped trucks must have the capability of responding to communications from roadside inspectors. These vehicles would need to take direction on where to stop, where to go, and when to park so that CVSA personnel could inspect the vehicle. They further commented that there will always be the possibility that inspectors would pull the ADS-equipped vehicle in either because of a visible safety concern or if the vehicle did not strictly respond to a system-generated request to pull over for inspection. Some inspectors randomly pull vehicles in for inspection. It was also suggested that it may be difficult to differentiate an ADS-equipped truck from other trucks, particularly at highway speeds.

Some inspectors raised safety concerns about inspecting ADS-equipped trucks without a safety operator or driver. They were concerned about inspecting a vehicle without the ability to communicate with it or control its movement. The ADS-equipped truck would have to maneuver over an inspection pit and remain in place until the truck was inspected. In the absence of an inspection pit, the ADS-equipped vehicle would need to remain parked until the underside of the vehicle was inspected. The experts felt that inspectors would not feel safe under an ADS-equipped vehicle even with appropriate safety procedures (i.e., wheel chocks were in place). Inspectors felt there was a need to be able to contact and talk directly to either a carrier's

dispatch or the technology developer monitoring the vehicle to perform a Level 1 inspection at roadside.

On the issue of whether the vehicle should be inspected at roadside, one inspector thought that ADS-equipped trucks should be inspected like any other vehicle. His concern with exempting these vehicles from inspection was that criminal elements might then use these types of vehicles in human trafficking or to transport illegal cargo such as illicit drugs.

One inspector felt that CVSA might consider a phased approach, involving Level 5 inspections for the next 5 years. His thoughts were that only a relatively small number of vehicles would be operating without a driver or a safety operator in that period. In the next phase, all vehicles would be required to have the capacity to be inspected roadside either physically or electronically. This would give technology developers time to transition from developing their ADSs to building out the electronic communications controlling the ADS-equipped vehicle. Electronic communications will be important not only for government systems at roadside but for communicating with the ADS-equipped truck when picking up and dropping off loads at a terminal or port facility.

Post-crash Inspections of ADS-equipped CMVs: FMCSA has the authority to inspect CMVs that have been involved in a crash. Typically, this is a Level I NAS Inspection that includes driver's license, Medical Examiner's Certificate, medical waiver, alcohol and drug testing, driver's RODS, HOS, seat belt, vehicle inspection report, and critical vehicle items such as the brake system, coupling devices, exhaust system, frame, fuel system, lights and turn signals, safe loading, steering mechanism, suspension, tires, van and open-top trailer bodies, wheels and rims, and windshield wipers. If some of the parts and accessories are damaged due to the crash, the officer may document any defects that need to be repaired before the vehicle can go back on the road.

Expert Opinion Regarding Post-crash Inspections of ADS-equipped CMVs: The study team asked inspectors to comment on changes needed to the FMCSRs regarding post-crash inspections. Inspectors did not feel that any changes were necessary for the mechanical side of an ADS-equipped vehicle. They did, however, feel that a whole new set of inspection criteria would be needed to evaluate whether the ADS contributed to the crash. They felt that ADS developers should be required to save and surrender video and data collected from the ADS. By using that data, a crash investigator should be able to determine whether the system itself was operating properly or whether it contributed to the crash. Inspectors felt that all ADS-equipped trucks involved in crashes should be inspected to determine whether mechanical components of the truck or the ADS contributed to the crash. They felt that the public would expect that each crash involving an ADS-equipped vehicle would be thoroughly investigated, which would include video and other data stored by the ADS.

5.3.3.4 Periodic Inspection—Annual Maintenance

Motor carriers are required to inspect each CMV at least once every 12 months. Some States require other periods for these inspections, such as every 6 months.

Summary of the Requirements – Periodic Inspections: The inspection must include all of the parts and accessories outlined in 49 CFR Chapter III, Subchapter B, Appendix G, *Minimum*

Periodic Inspection Standards.[35] The regulation specifies that the term "CMV" includes each vehicle in a combination vehicle. For example, for a tractor semitrailer, full trailer combination, the tractor, semitrailer, and the full trailer (including the converter dolly if so equipped) must each be inspected. Motor carriers must inspect all motor vehicles subject to their control, while IEPs must inspect intermodal equipment that is interchanged (or intended for interchange) to motor carriers in intermodal transportation.

A motor carrier must not use a CMV, and an IEP must not tender equipment to a motor carrier for interchange, unless each component identified in the Minimum Period Inspection Standards has passed an inspection during the preceding 12 months and documentation of the periodic inspection is on the vehicle. The documentation may be the inspection report or some other form of documentation based on the inspection report (e.g., a sticker or decal with the date of the inspection, the name/address of the entity where the inspection report is maintained, information uniquely identifying the vehicle inspected, and a certification that the vehicle passed the inspection).

A motor carrier or IEP may self-inspect vehicles or equipment under their control that are not subject to an inspection under 49 CFR 396.23(a)(1). In lieu of a self-inspection, a motor carrier or IEP may choose to have a commercial garage, fleet leasing company, truck stop, or other similar commercial business perform the inspection as its agent, provided the business operates and maintains facilities appropriate for commercial vehicle inspections and it employs qualified inspectors.

Periodic Inspection Considerations for ADS-equipped CMVs: Table 27 summarizes the challenges that existing requirements may pose to ADS-equipped vehicles, along with any potential changes to the regulations that may be needed to enable safe deployment of ADS-equipped vehicles. Once the safety operator and/or driver role is removed, the ADS-equipped vehicle will be unrestrained in terms of the miles or hours it can operate. As a result, it is believed that motor carriers will employ these vehicles 24 hours a day, 365 days a year, if they have freight that needs to be moved. As noted earlier in this report, in 2021, FHWA determined that the average combination truck travels 59,900 miles per year.[36] Without the constraints of a CMV driver's HOS, these vehicles could operate 24 hours a day minus the time for pre-trip inspections, dropping and picking up trailers, and refueling. All totaled, the vehicle miles per year could go from 59,500 miles per year to more than 350,000 miles per year (a possible scenario based on 20 hours a day at 50 miles an hour on average for 355 days a year). An ADS-equipped truck could travel more than 5 times the number of miles that a typical truck with a driver does today, which means it could transport 5 times the amount of freight that an average truck transports today.

Table 8. Summary of considerations around 49 CFR 396.17 (periodic inspections).

Challenges and Considerations for ADS-equipped Vehicles	FMCSR Changes and Considerations	Inspection Alternatives and Considerations
1. Inspection not done by the driver – no difference in inspection requirement for mechanical systems. 2. High operational mileage would suggest the need for increasing the frequency of the periodic inspection; instead of annually, inspections should be conducted once a quarter.	1. Need to add the external inspection of ADS sensors and computer diagnostics. 2. Need to change the frequency of the inspections and who should conduct the inspection.	1. Some vehicles may have limited usage during certain periods; therefore, time-based inspections for ADS-equipped trucks may not be optimal. An alternative is a mileage-based inspections requirement with a minimum time basis. 2. Consideration should be given to having a third party conduct at least one of the periodic inspections.

As previously stated in the literature review, researchers found that the Quebec mandatory mechanical inspection program, which amounts to their annual inspection of commercial vehicles, was only effective for 3 months, and that the periodic inspection was really not frequent enough to keep trucks that had developed mechanical problems off the road. The authors recommended more frequent inspection of vehicles coupled with an enhanced pre-trip inspection. Therefore, more frequent periodic inspection is needed, no matter whether the truck is a new or older model vehicle. The engineers in this study stated that "more frequent checks were needed particularly for brakes and tires" because of wear and tear from the roadway. This recommendation was for standard vehicles, and some Canadian provinces began a biannual program of inspecting vehicles based on the findings of this study.

Expert Opinion Regarding Periodic Inspections of ADS-equipped CMVs: There is almost universal agreement among inspectors that the periodic inspection of ADS-equipped trucks would not be that much different from the inspections that are currently being conducted on similar vehicle classes today. The driver is generally not present during these inspections. What will be different is the operating environment and, more generally, the number of miles that a truck will operate in a particular year. Inspectors felt that ADS-equipped trucks were likely to be driven more miles per year and therefore should be inspected more frequently. Most inspectors felt that the frequency of inspection should be conducted at a minimum of at least once a quarter. If a vehicle is driven 350,000 miles per year, a quarterly inspection would equate to about 87,500 miles between inspections. This would mean that there would be more miles between inspections compared to the FHWA-determined annual average of 59,900 miles for combination truck CMVs.

One inspector suggested that an alternative inspection regime could be tied to vehicle mileage. Perhaps some motor carriers will not operate at a high operating tempo as projected. In this case, one alternative would be for motor carriers to opt into a mileage-based inspection schedule. For

example, when reaching out to one of the leading fleet maintenance organizations, the study team learned that this organization inspects its vehicles every 40,000 miles.

Additionally, one inspector suggested that at least one of the inspections should be conducted by a third party certified to conduct these types of mechanical inspections—basically, a certified organization that does not benefit from the results of the inspection.

5.3.3.5 Law Enforcement—Safety Inspections

The National Institute of Justice, working with the RAND Corporation and the Police Executive Research Forum, developed an expert panel report on policing AVs.[37] This report identified four likely scenarios in which law enforcement would likely interact with autonomous trucks:

1. Traffic Stops. While it is unlikely that ADS-equipped trucks will violate traffic laws, traffic stops may arise from visible safety concerns (unsecure doors or straps, smoke, improper vehicle parking, etc.).
2. Collisions. Inevitably there will be crashes between ADS-equipped trucks and other vehicles operating in their vicinity.
3. Emergencies. ADS trucks will have to take law enforcement direction for evacuation and detours.
4. Tangential Interactions. Law enforcement may want to use information obtained from an ADS-equipped vehicle as evidence in investigations.

The expert panel report concluded that communications with ADS-equipped trucks will be one of the most important capabilities that largely does not exist today. Law enforcement will need the ability to interface with the vehicle and vehicle owner. The vehicle must be able to take direction from law enforcement. ADS technology will need to recognize law enforcement signals such as lights, sirens, and basic hand signals from officers. Law enforcement needs a means to know whether a vehicle is operating without a driver or safety operator. Additionally, law enforcement needs a means to communicate with the vehicle and/or the vehicle owner. The expert panel report concluded that there was a need for "research on developing a standard electronic means for law enforcement to communicate securely with autonomous vehicles on the road."

Universal Electronic Vehicle Identification (EVI) may provide a means of communicating between law enforcement and the ADS-equipped truck. This technology could identify a CMV electronically while the vehicle is in motion and convey to law enforcement that the vehicle has and is being driven by ADS. Universal EVI does not provide the ability for law enforcement and the motor carrier to interact so that law enforcement can have some control over vehicle movement.

The concept of ADS remote operation originated with the U.S. Army and drone management on the battlefield. One soldier can operate multiple drones and fly them into battle space. When a drone arrives at its destination, the operator will remotely connect to it to see the video from the drone and then make battlefield decisions.

Remote assistance for ADS-equipped trucks can be similar. The role of the dispatcher within a motor carrier could be expanded from controlling 50–100 drivers to 10–20 trucks that are operating autonomously. The dispatcher could be provided a warning of a possible operational concern and then remotely connect to the vehicle, thereby providing direction to the truck when it either loses situational awareness or has some sort of mechanical issue. Once the vehicle detects law enforcement, the dispatcher could take over control of the vehicle and take direction from police officers to stop or follow hand signals for detours or for truck inspections. Adding remote assistance roles to a dispatcher could result in a need for further regulations qualifying the dispatcher to operate a CMV, possibly including certifications and HOS requirements.

The concept of remote assistance could work well with regard to pickup and delivery of trailers/containers at a motor carrier's depot. Several organizations have been working to develop remote assistance capabilities that could be utilized within the commercial trucking industry. Fully functional remote assistance would help the deployment of ADS-equipped trucks on public roads, as remote human intervention can overcome critical situations that the ADS-equipped vehicle cannot handle by itself. One of the technical challenges of remote assistance is the lack of network coverage along major freight corridors. The deployment of 5G is not expected to be complete before 2025, and current network capabilities cannot always guarantee the bandwidth and latency requirements of remote assistance. Dynamic video compression technology delivers a continuous video feed to the teleoperator. Funding for U.S. infrastructure should help to expedite network coverage to rural America, particularly along highways.

Law Enforcement/Safety Inspection Considerations for ADS-equipped CMVs: Table 28 summarizes the challenges that existing requirements may pose to ADS-equipped vehicles, along with any potential changes that may need to be applied to regulations to enable safe deployment of ADS-equipped vehicles.

Table 9. Summary of considerations around 49 CFR 350 & 368.7 (interactions with law enforcement/inspection personnel).

Challenges and Considerations for ADS-equipped Vehicles	FMCSR Changes and Considerations	Inspection Alternatives and Considerations
1. There are a number of scenarios where enforcement and the ADS vehicle will need to interact: traffic stops, collisions, emergencies, and to assist in investigations. 2. Law enforcement will need to be able to communicate with the vehicle/motor carrier in real time.	1. Traffic stops are generally governed by the Fourth Amendment of the U.S. Constitution and State and Local statutes. 49 CFR 350.103, 350.111, and 350.201 state that traffic enforcement agencies and political jurisdictions partner to establish programs to improve carrier, CMV, and driver safety, which includes stopping vehicles on highways, streets, or roads for moving violations and safety inspections. 49 CFR 368.7 states that certificates of registration must be maintained in all vehicles and made available	1. Universal EVI should help provide information to law enforcement that the vehicle is operating in autonomous mode. 2. Remote assistance could provide the interface for communication between law

Challenges and Considerations for ADS-equipped Vehicles	FMCSR Changes and Considerations	Inspection Alternatives and Considerations
	upon request to authorized inspectors and enforcement officers.(38)	enforcement and the vehicle/motor carrier.

5.3.4 Enhanced CMV Inspection Program

While the Enhanced CMV Inspection Program is not a regulatory requirement, it is already becoming a common practice within the industry. This section will provide both a high-level overview of the enhanced inspection process and an overview of the required training currently offered to become certified to perform an enhanced inspection of an ADS-equipped CMV.

When does an enhanced inspection occur, and is it relevant for all CMVs?

The CVSA Enhanced CMV Inspection Standard was designed specifically with ADS-equipped trucks in mind. Inspections are to be performed by trained and certified individuals who are not necessarily drivers. These inspections will occur at various points during the deployment of the ADS-equipped vehicle.

- The initial inspection shall be performed at the point of origin prior to allowing the vehicle to be placed into service on the highway. To pass this level of inspection, the vehicle and any attached trailer must be found to be "defect free."
- Additionally, these ADS-equipped vehicles will be subject to additional "in transit" inspections or an inspection at least once every 24 hours. During this level of inspection, certain non-safety critical defects will be noted for repair, but the vehicle can still be allowed to proceed to its destination. Upon arrival at its destination point, these defects must be corrected prior to returning the equipment to service.
- If at any time during the 24-hour period the ADS-equipped vehicle is connected to a different trailer, a new initial inspection shall be required to once again ensure all equipment is defect free prior to being placed into service on the highway.

5.3.4.1 ADS Working Group

FMCSA has actively supported the development of initial recommendations for inspecting ADS-equipped CMVs. In September 2018, CVSA's Enforcement and Industry Modernization Committee, in cooperation with FMCSA, established an Automated CMV Working Group (with diverse representation across CVSA's membership types)[2] to address the inspection process for ADS-equipped trucks. The Automated CMV Working Group has:

- Assessed the latest advances in CMV automation and developed recommended approaches for inspecting ADS-equipped vehicles based on stakeholder interviews;

[2] CVSA membership types include Class I (State/provincial/territorial), Class II (local enforcement), Class III (associate), and Class IV (Federal).

performed research into best practices, current deployment, and testing trends; and gathered input from CVSA members.

- Completed a Phase 1 report, which provided recommendations for inspection requirements and procedures for ADS-equipped CMVs.
- Developed a matrix of ADS-equipped truck inspection procedures for each of the SAE levels of automation.
- Made initial recommendations regarding possible changes to FMCSA and NHTSA regulations and CVSA policies and training (in the context of ADS-equipped CMVs).

A few issues identified by the working group are still "unresolved," particularly regarding safety standards and the data that ADS-equipped trucks need to transmit to the roadside.

In March 2020, the ATA proposed the creation of a new task force to examine the inspection of ADS-equipped vehicles. This task force was drawn from the fleet maintenance, component supplier, and ADS provider communities within ATA's Technology and Maintenance Council and partnered with CVSA's Automated CMV Working Group to create an information report exploring consensus-based approaches to inspection and enforcement for SAE Levels 4 and 5 ADS-equipped trucks. Kodiak Robotics, Embark, Ike, and TuSimple are examples of ADS trucking developers that have supported the task force in developing consensus-based standards for ADS-equipped vehicles.

5.3.4.2 Training

As of the writing of this report, training for the enhanced inspection program has been made available to both industry partners and law enforcement, with only a small number of trained and certified inspectors having completed it. This 5-day training course took place in Grapevine, Texas, in February 2023. Attendees included representatives from "self-driving" developers, assorted trucking companies exploring their future options of adding ADS-equipped vehicles to their fleets, law enforcement (roadside inspectors), and VTTI staff to both participate in the training and better understand how this process will integrate into the combined fleet operations that will make their way to highways across North America in the coming years. These classes will be ongoing.

Classroom: The classroom training portion of the enhanced inspection course was presented by experienced former roadside inspectors from the United States and Canada who currently worked for CVSA. Classroom training spanned a period of 3 days, with each class day ending outside working with instructors to identify and discuss topics from the training. Each afternoon, an instructor worked with students using equipment provided by FedEx and Kodiak Robotics. This approach allowed all attendees, including those with no prior mechanical or inspection experience, to better understand and identify individual parts and systems on the trucks and seek help from an instructor on an individual level.

As covered previously in section 5.3.2.5, each student was provided with both a participant manual and an even more in-depth resource that included the current (as of 2023) *Roadside Inspections Handbook* for inspectors. In addition to the manuals, CVSA instructors provided numerous example parts and other items, which were passed around the class for students to

better understand how the various truck parts and sub-parts work and provide visible examples of defects, etc.

The Handbook provided to all participants included the following breakdown of categories of instruction and required inspection:

- Power Train
- Suspension
- Brakes (Air)
- Steering
- Instruments and Auxiliary Equipment
- Lamps
- Electrical System
- Body
- Tires and Wheels
- Coupling Devices

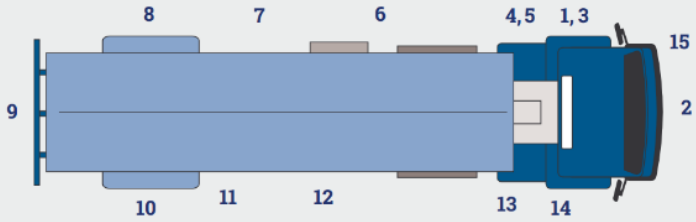
During the classroom portion of the training, students received detailed insight into each of the categories and their subcategories. The subcategories allowed both instructors and trainees to further identify and explore individual parts and systems that a certified Enhanced Inspector would be required to examine. Beyond gaining an understanding of and familiarity with these systems and parts, each student received training on what would or would not be considered a defect during an inspection.

CVSA provided this information via illustrations, a glossary of terms, and easy-to-read/interpret charts for each system and individual item that required inspection. These tables were broken down further into columns for “Dispatch” inspections and “In-Transit” inspections. As referenced previously, the enhanced inspection training made it clear that any ADS-equipped vehicle and attached trailer must be defect free to be cleared and released for service on a public highway. The training, and by extension the CVSA manual, used clear and unambiguous wording, descriptions, and illustrations as to what is or is not a defect.

The enhanced inspection manual also provides both a step-by-step inspection procedure form as well as an Enhanced CMV Inspection Vehicle Report for the inspector. Copies of these current two-page forms (as of September 28, 2023) are included as Figure 43 and Figure 44.

Inspection Procedure

Enhanced CMV Inspection *(for motor carrier operations)*



1 Prepare the Vehicle for Inspection

- Check the periodic inspection(s) for validity.
- Check the license plate, DOT number and carrier name.
- Place the chock blocks, put the vehicle transmission in neutral, release all the brakes, ensure the air pressure is at maximum, turn engine off and ensure the key is in the "on" position.
- Inspect the "ABS" malfunction lamp(s) on the dash for the tractor and trailer.

2 Inspect Front of Tractor (and the rear for lighting)

- Check headlamps (low and high beam), ID, clearance, turn signals, and any other required lamps for improper color, operation, mounting and visibility.
- Ensure the ABS lamp on the trailer is marked and not activated.
- Inspect the bumper for security.
- Inspect ADS sensors (camera, lidar, radar)

3 Inspect Left Front Side of Tractor

- Inspect the hood and latch.
- Check front wheel, rim, hub and tire.
- Inspect visible portions of the frame.
- Inspection the door for operation.
- Check the side windows and rearview mirror.

4 Inspect Left Saddle Tank Area

- Check fuel tank area.
- Check exhaust system, if applicable.
- Inspect the battery for security and leaks, if visible.
- Inspect visible portions of the frame and mounts.

5 Inspect Trailer Front/Rear of Tractor

- Check air and electrical lines.
- Inspect the cab air suspension, shocks and reefer, if applicable.
- Inspect the cab reflective markings
- Inspect the headache rack or bulkhead of trailer.
- Inspect the fenders for security.

6 Inspect Left Rear Tractor Area

- Check wheels, rims, hubs and tires
- Check the lower, upper and slider components of the fifth wheel assembly.
- Check all required lamps and reflective tape.
- Inspect the rear window, if applicable.
- Check the condition of the mudflaps/ fenders.
- Inspect the reefer, if applicable.

7 Inspect Left Side of Trailer

- Inspect the landing gear.
- Check frame and body (upper/lower rails/ crossmembers of trailer).
- Check the condition of the aerodynamic device, if applicable.
- Check the reflective tape along the side of the trailer.

8 Inspect Left Rear Trailer Wheels

- Check wheels, rims, hubs and tires.
- Check the frame and visible suspension components.
- Ensure the sliding subframe is secured and the pins, guides and handle are in place.
- Inspect the condition of the mudflaps.

9 Inspect Rear of Trailer

- Inspect the reflective markings.
- Inspect the rear impact guard, if applicable.
- Inspect the aerodynamic device, if applicable.
- Check the condition of the cargo doors and the security of the cargo.
- Check the tail lamps, license plate lamp and lamp on projected load.

10 Inspect Right Rear Trailer Wheels

- Check as in step 8.

11 Inspect Right Side of Trailer

- Check as in step 7.
- Check the spare tire security, if applicable.

12 Inspect Right Rear Tractor Area

- Check as in step 6.

13 Inspect Right Saddle Tank Area

- Check as in step 4.

14 Inspect Right Front Side of Tractor

- Check as in step 3.

15 Inspect Steering Axle (activate hazard lamps)

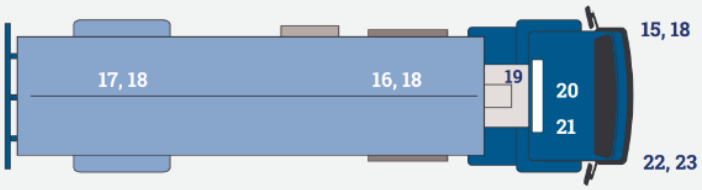
- Inspect hazard lamps.

Pull the hood of the tractor to get a better view of components.

- Check steering system (power steering fluid), front suspension and front brake components.
- Scribe the brakes, if necessary and determine chamber size.
- Check the front axle, frame and crossmembers.
- Inspect visible inside sidewall tire condition.

over

Inspection Procedure: Enhanced CMV Inspection *(for motor carrier operations)*



16 Inspect Axles 2 and/or 3

- Check driveline/driveshaft.
- Inspect the exhaust system for security and leaks.
- Check the suspension, brake components and tires on both sides.
- Check the air tanks for security and condition.
- Scribe the brakes, if necessary and determine chamber size.
- Inspect the axles, frame members and crossmembers.
- Check the hazard lamps at rear of tractor for operation.

17 Inspect Axles 4 and/or 5

- Check the suspension, brake components and tires on both sides.
- Scribe the brakes, if necessary and determine chamber size.
- Inspect the axles, frame members and crossmembers.
- Check the hazards lamps at rear of trailer.

18 Check Brake Adjustment

- Ensure air pressure is 90-100 psi (620-690 kPa).
- Apply the service brakes fully (person or device).
- Measure and record the pushrod travel (if applicable) and ensure brake lining to drum contact.
- Listen for air leaks.
- Inspect the brake lamps on the tractor and trailer.

19 Inspect the Tractor Protection System

Note: This procedure tests both the tractor protection system and the emergency brakes.

- Ensure the emergency brakes are still released and then disconnect both brake lines from the trailer. Ensure the air stops leaking from the supply line before 20 psi (138 kPa). Inspect for bleedback from the trailer.
- Apply a full brake application.
- Listen for air leaking from the service/supply gladhands.
- Reconnect the lines.

20 Inspect In-Cab Area

- Inspect the driver's seat and seatbelt.
- Inspect the interior and exterior sun visor condition.
- Check windshield for damage, wipers and washers for proper operation.
- Check the function of the horn.
- Record the odometer and check the speedometer.
- Check for a fault on the ESC or RSS for trailer.
- Inspect the ADS fault system.
- With air pressure at 80 psi (551 kPa), apply the service brake and conduct the air pressure loss rate test. (combination - loss of more than 4 psi (28 kPa) in one minute/tractor only - loss of 1 psi (7 kPa) in one minute)

Start the tractor and push in the dash valves (parking brakes released). While engine is at idle (600 – 800 rpms):

- Ensure that the low air pressure warning device activates by pumping the foot valve to exhaust air.
- Build air up to 80 psi (551 kPa) and check the function of the air gauge(s).
- Conduct the air pressure buildup test (builds from 85-100 psi (587-690 kPa) within two minutes).
- Ensure the governor cuts out before 145 psi (1000 kPa).
- Ensure the pressure does not drop more than 20 psi (138 kPa) on brake application.
- With the engine running, measure steering wheel lash while wheels are straight.
- Check the telescopic/tilt steering, steering wheel and column.
- Inspect the fire extinguisher and hazard warning devices.
- Check the defroster/heater/brake pedal and accelerator pedal.
- Check the floor and condition of the cab for holes, etc.

21 Check Fifth Wheel/Tractor Parking Brakes

Caution: If conducted improperly, this method of checking for fifth wheel movement can result in serious damage to the vehicle.

- Remove the chock blocks and apply the spring brakes on the trailer.
- Put the tractor in drive/reverse and feel for excessive play in the fifth wheel.
- Apply the tractor spring brakes only and conduct the parking brake test.

22 Inspect Cargo Securement

- Ensure the cargo is secured, blocked or tied down, as required.

23 Complete the Vehicle Inspection Report

- Complete a trip inspection report.
- Record and repair any defects that are found during a dispatch inspection OR record defects that do not require immediate attention during an in-transit inspection.

Note: Fifth wheel movement, ABS malfunction lamp operation on trailer and reverse lamp cannot be adequately inspected in a one-person inspection – it is recommended that if there is another person available to get assistance for these items.

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Figure 2. Illustration. Enhanced CMV Inspection procedure form.

Enhanced CMV Inspection Report – Tractor/Semitrailer (Air Brakes)

Refer to the Enhanced Commercial Motor Vehicle Inspection Standard for Defect Criteria

Inspection Date/Time:_____ Location:_____ Odometer Reading:_____

Plate/Unit Number(s):_____ Dispatch/In-Transit (Circle applicable inspection) Name/Signature: _____ (Printed name and signature of inspector)

I – Inspection Component (Mark "X", if Defective) / **E** – Enhanced CMV Inspection Standard Reference

Inspection Step	I	E
2 – Front of Tractor	**X**	**E**
• Periodic Inspection Decal/Document		Valid for 3 months
• Headlamp		6.1.a/b
• Turn Signal		6.1.a/e
• Hazard Warning Lamp		6.1.a/f
• Clearance Lamp		6.1.a/h
• Identification Lamp		6.1.a/i
• Bumper		8.10.a-b
• ADS System		5.10.a
3 – Left Front Side of Tractor	**I**	**E**
• Hood or Engine Enclosure		8.1.a-d
• Front fender		8.3.d
• Cab and Passenger Vehicle Body		8.3.a-c
• Frame, Rails and Mounts		8.5.a-b
• Cab Door		8.7.a-b
• Side Windows		8.12.a-b
• Rear-view Mirror		8.16.a-d
• Tires - Tread Depth		9.1.a
• Tires - Tread/Sidewall Condition		9.2.a-d
• Tires - Sidewall Markings		9.3.a-b
• Tires - Inflation		9.4.a-c
• Wheels - Hub		9.5.a-e
• Wheels - Rim		9.6.a
• Wheels - Spoke		9.7.a-c
• Wheels - Disc		9.8.a
• Wheels - Fasteners		9.9.a-b
4 – Left Saddle Tank Area	**I**	**E**
• Exhaust System		1.2.a-g
• Fuel System		1.4.a-e
• Battery		7.2.a-d
• Frame, Rails and Mounts		8.5.a-b
5 – Trailer Front	**I**	**E**
• Air System (Gladhands/Fittings/Leaks)		3.11.a-c
• Headache Rack, if applicable		5.9.a
• Wiring		7.1.a-c
• Trailer Cord		7.3.a-b
• Air Suspended Cab		8.2.a-d
• Unitized Body Elements (bulkhead)		8.6.a
• Reefer or Auxiliary Power Unit		8.9.a
6 – Left Rear Tractor Area	**I**	**E**
• Tail Lamp		6.1.a/c
• Stop (Brake Lamp)		6.1.a/d
• Turn Signals		6.1.a/e
• Hazard Warning Lamps		6.1.a/f
• Back up/Reverse Lamp		6.1.a/j
• License Plate Lamp		6.1.a/k
• Reflex Reflector		6.2.a-c
• Retro-Reflective Marking		6.3.a-d
• Rear Window		8.13.a
• Fender/Mudflap		8.19.a
• Tire Tread Depth		9.1.b
• Tires - Tread/Sidewall Condition		9.2.a-d
• Tires - Sidewall Markings		9.3.a-b
• Tires - Inflation		9.4.a-c
• Wheels - Hub		9.5.a-e
• Wheels - Rim		9.6.a
• Wheels - Spoke		9.7.a-c
• Wheels - Disc		9.8.a
• Wheels - Fasteners		9.9.a-b
• Automated Coupling Device		10.2.a
• Fifth Wheel Coupler		10.3.a-f

Inspection Step	I	E
7 – Left Side of Trailer	**X**	
• Left Side Marker Lamp		6.1a/g
• Retro-Reflective Marking		6.3.a-d
• Cargo Body		8.4.a-i
• Frame, Rails and Mounts		8.5.a-b
• Landing Gear on Trailer		8.20.a-c
• Sliding Axle Assembly		8.21.a-c
• Aerodynamic Device		8.22.a
8 – Left Rear of Trailer	**I**	**E**
• Tires - Tread Depth		9.1.b
• Tires - Tread/Sidewall Condition		9.2.a-d
• Tires - Sidewall Markings		9.3.a-b
• Tires - Inflation		9.4.a-c
• Wheels - Hub		9.5.a-e
• Wheels - Rim		9.6.a
• Wheels - Spoke		9.7.a-c
• Wheels - Disc		9.8.a
• Wheels - Fasteners		9.9.a-b
9 – Rear of Trailer	**I**	**E**
• ABS Malfunction Lamp		3.19.a
• Tail Lamp		6.1.a/c
• Stop (Brake Lamp)		6.1.a/d
• Turn Signals		6.1.a/e
• Hazard Warning Lamp		6.1.a/f
• Clearance Lamp		6.1.a/h
• Identification Lamp		6.1.a/i
• License Plate Lamp		6.1.a/k
• Projecting Load Lamp, if equipped		6.1.l
• Reflex Reflector		6.2.a-c
• Retro-Reflective Marking		6.3.a-d
• Cargo Door		8.7.a-b
• Aerodynamic Device		8.22.a
• Rear Impact Guard		8.23.a-b
10 – Right Rear of Trailer	**I**	**E**
• Frame, Rails and Mounts		8.5.a-b
• Tire Tread Depth		9.1.b
• Tires - Tread/Sidewall Condition		9.2.a-d
• Tires - Sidewall Markings		9.3.a-b
• Tires - Inflation		9.4.a-c
• Wheels - Hub		9.5.a-e
• Wheels - Rim		9.6.a
• Wheels - Spoke		9.7.a-c
• Wheels - Disc		9.8.a.
• Wheels - Fasteners		9.9.a-b
11 – Right Side of Trailer	**I**	**E**
• Right Side Marker Lamp		6.1.a/g
• Retro-Reflective Marking		6.3.a-d
• Cargo Body		8.4.a-i
• Frame, Rails and Mounts		8.5.a-b
• Landing Gear on Trailer		8.20.a-c
• Sliding Axle Assembly		8.21.a-c
• Aerodynamic Device		8.22.a
12 – Right Rear Tractor Area	**I**	**E**
• Retro-Reflective Marking		6.3.a-d
• Air Suspended Cab		8.2.a-d
• Frame, Rails and Mounts		8.5.a-b
• Fender/Mudflap		8.19.a
• Tire Tread Depth		9.1.b
• Tires - Tread/Sidewall Condition		9.2.a-d
• Tires - Sidewall Markings		9.3.a-b
• Tires - Inflation		9.4.a-c

Inspection Step	I	E
• 12 – Right Rear Tractor Area (cont'd)	**X**	
• Wheels - Hub		9.5.a-e
• Wheels - Rim		9.6.a
• Wheels - Spoke		9.7.a-c
• Wheels - Disc		9.8.a
• Wheels - Fasteners		9.9.a-b
• Fifth Wheel Coupler		10.3.a-f
13 – Right Saddle Tank Area	**I**	**E**
• Exhaust System		1.2.a-g
• Fuel System		1.4.a-e
14 – Right Front Side of Tractorr	**I**	**E**
• Hood or Engine Enclosure		8.1.a-d
• Cab and Passenger Vehicle Body		8.3.a-c
• Cab Door		8.7.a-b
• Fender		8.3.d
• Frame, Rails and Mounts		8.5.a-b
• Side Windows		8.12.a-b
• Rear-view Mirror		8.16.a-d
• Tire Tread Depth		9.1.a
• Tires - Tread/Sidewall Condition		9.2.a-d
• Tires - Sidewall Markings		9.3.a-b
• Tires - Inflation		9.4.a-c
• Wheels - Hub		9.5.a-e
• Wheels - Rim		9.6.a
• Wheels - Spoke		9.7.a-c
• Wheels - Disc		9.8.a
• Wheels - Fasteners		9.9.a-b
15 – Steering Axle	**I**	**E**
• Spring Hangers		2.1.a-b
• Axle Tracking Components		2.2.a-e
• Axle and Axle Assembly		2.3.a
• Spring and Spring Attachment		2.4.a-h
• Shock Absorber		2.6.a-c
• Air Compressor		3.1.a-c
• Air System (Fittings/Leaks)		3.11.a-c
• Brake Chambers		3.12.a-c
• Brake Drums/Shoes/Linings/Seals		3.13.a-e
• S-Cam/pushrod/clevis/adjuster/etc.		3.14.a-e
• Disc Brakes (calipers/rotors/pads)		3.17.a-e
• Steering control and linkage		4.1.a-i
• Power Steering System		4.2.a-f
16 – Axle 2 and 3 Undercarriage	**I**	**E**
• Drive Shaft and Differential		1.3.a-e
• Spring Hangers		2.1.a-b
• Axle Tracking Components		2.2.a-e
• Axle and Axle Assembly		2.3.a
• Spring and Spring Attachment		2.4.a-h
• Air Suspension		2.5.a-d
• Shock Absorber		2.6.a-c
• Air Tanks/Reservoirs		3.4.a-c
• Air System (Fittings/Leaks)		3.11.a-c
• Brake Chambers		3.12.a-c
• Brake Drums/Shoes/Linings/Seals		3.13.a-e
• S-Cam/pushrod/clevis/adjuster/etc.		3.14.a-e
• Disc Brakes (calipers/rotors/pads)		3.17.a-e
• Frame, Rails and Mounts		8.5.a-b
17 – Axle 4 and 5 Undercarriage	**I**	**E**
• Spring Hangers		2.1.a-b
• Axle Tracking Components		2.2.a-e
• Axle and Axle Assembly		2.3.a
• Spring and Spring Attachment		2.4.a-h
• Air Suspension		2.5.a-d
• Shock Absorber		2.6.a-c
• Air System Leakage		3.3.a-b
• Air Tanks/Reservoirs		3.4.a-c
• Air System (Fittings/Leaks)		3.11.a-c
• Brake Chambers		3.12.a-c
• Brake Drums/Shoes/Linings/Seals		3.13.a-e
• S-Cam/pushrod/clevis/adjuster/etc.		3.14.a-e
• Disc Brakes (calipers/rotors/pads)		3.17.a-e
• Frame, Rails and Mounts		8.5.a-b

Inspection Step	I	E
18 – Brake Adjustment	**X**	
• S-Cam Brake Adjustment		3.15.a
• Wedge Brake Adjustment		3.16.a
19 – Tractor Protection System	**I**	**E**
• Tractor Protection Valve		3.8.a
• Trailer Supply Valve		3.8.b
• Bleedback Valve (Trailer)		3.8.c.
20 – In Cab Inspection	**I**	**E**
• Accelerator Pedal		1.1.a-d
• Air Pressure Build-up/Loss Rate		3.2.a-b/g
• Low Pressure Warning		3.2.c
• Air Pressure Gauge		3.2.d
• Air Pressure Drop/Reserve		3.2.e
• Air Leakage		3.2.f./3.3.a
• Brake Pedal/Actuator		3.5.a-c
• Treadle Valve		3.6.a-b
• Brake Valves and Controls		3.7.a
• Parking/Emergency Brake Tractor		3.9.a-b
• Parking/Emergency Brake Trailer		3.10.a-b
• ABS Malfunction Lamp(s) on Dash		3.18.a-b
• Stability Control on Truck		3.20.a
• ESC/RSS on Trailer		3.21.a
• Steering Operation		4.3.a-d
• Fire Extinguisher		5.1.a-b
• Hazard Warning Kit		5.2.a
• Horn		5.3.a-b
• Speedometer/Odometer		5.4.a/5.5.a
• Windshield Wiper/Washer		5.6.a-d
• Heater/Defroster		5.7.a-b
• Auxiliary Heater		5.8.a
• Automated Driving System (ADS)		5.10.a
• Windshield		8.11.a-f
• Interior Sun Visor		8.14.a-c
• Exterior Windshield Sun Visor		8.15.a
• Seat		8.17.a-b
• Seatbelt		8.18.a-d
21 – Fifth Wheel Movement	**I**	**E**
• Excessive Play Between Parts		10.1.a/10.3.c-e
22 – Cargo Securement	**I**	**E**
• Equipment Mounted on Vehicle		8.9.a
• Inadequate blocking and bracing		393.100/NSC 10
• Inadequate number of tiedowns		393.110/NSC 10

X = Item is a defect in the Standard

Periodic Inspection - Tractor _____ **(date)**

Trailer _____ **(date)**

Brake Measurements

Chamber Size/Type					
Axle	**Axle 1**	**Axle 2**	**Axle 3**	**Axle 4**	**Axle 5**
Right Side					
Left Side					

Comments:

Figure 3. Illustration. Enhanced CMV Inspection Report – Tractor/Semitrailer (Air Brakes), procedure form.

In addition to the inspection process for the trucks and trailers themselves, the trainees also received a course of instruction on how to properly inspect the cargo for securement. During this block of instruction, the students learned about differing securement requirements based on load types. This included such things as inspecting load locks, straps, and chain thickness. In addition to the securement devices themselves, students also learned about secondary items that should be used to properly secure various loads. Examples include learning about attachment points, blocking, bracing, dunnage, edge protectors, friction mats, void fillers, and understanding the Working Load Limit when using these items in combination with the securement devices themselves.

Hands-on Vehicle Inspection: Training for the enhanced inspection procedure went beyond the classroom to include a hands-on demonstration of knowledge. During this phase of training, instructors prepared a group of trucks with a series of "defects" that the students were expected to locate and identify while performing a full enhanced inspection on a non-ADS-equipped truck and trailer set. As part of the training process, these defects were consistent across the trucks used during this class. These defects were not, however, the only ones that may be used in future training classes. This was by design in order to prevent complacency on the part of students who, for whatever reason, need to repeat the class, as well as for the purpose of recertification. The complete list of potential defects is maintained by CVSA instructor staff and is not intended to be released in order to maintain the integrity of the program.

Step 1: Following the inspection form in Figure 43, the students began their inspections by approaching their assigned vehicle. Students checked for a current annual inspection decal, license plate, DOT number, and carrier name. With the engine running, the students placed chock blocks around the tractor's drive wheels, placed the vehicle in neutral, released the brakes, ensured the air supply pressure was at maximum, and then turned the engine off and placed the ignition key in the "on" position. Students verified that the ABS malfunction lamps properly illuminated on the dashboard and the trailer.

Step 2: Students then moved to the front of the tractor to verify the headlights (low and high beam) worked properly and that all clearance, signal, and other required lamps worked, were the proper color, and were clearly visible. Rear tractor lights were also checked at this time. In this step, students were also expected to inspect the front bumper and ensure that all ADS sensors (e.g., cameras, radar, lidar) were properly and securely mounted and that the ABS light on the trailer had not remained illuminated.

Step 3: Students were then expected to check the left front side of the tractor to include the hood latch, front wheel, rim, hub, and tire as well as visible portions of the frame. The driver's door, side mirrors, and windows were checked for proper operation.

Step 4: Next, the left saddle tank area was inspected. This included tank securement, leakage, cap presence, batteries confirmed free of leaks, and, if applicable, confirming the exhaust was properly mounted and free of damage.

Step 5: Students moved on to inspect the front of the trailer and rear area of the tractor. In this step, the students checked the condition of the air and electrical lines, cab air suspension shocks, and refrigeration unit, if present. The cab was inspected to ensure the presence of the required reflective material and rear fenders. If present, the headache rack or bulkhead was inspected for proper mounting, to include any improperly secured materials.

Step 6: Students inspected the left rear area of the tractor to include the wheels, rims, hubs, and tires. Visible portions of the frame were inspected for damage, cracks, or excessive rust. In addition, the fifth wheel assembly and upper and lower slider components were inspected. Students also checked the condition of any rear windows, if present, and confirmed the presence (if required) and condition of the mud flaps.

Step 7: Students next inspected the left (driver's) side of the trailer, checking the frame and body for corrosion fatigue, damage to the upper and lower rails, and cracked, broken, or missing crossmembers or other defective body parts. As part of the inspection of the trailer body, all panels were checked for loose or missing rivets or bolts. The landing gear was inspected to confirm no parts were loose or missing and that the handle could be properly stowed. If present, any aerodynamic devices were inspected for damage and loose or improper mounting. All required reflective markers were inspected to confirm proper placement and that minimum requirements were met.

Step 8: While still inspecting the left side of the trailer, students moved on to the left side hubs, wheels, tires, brakes, suspension, sliding subframe, and mudflaps. Students checked items such as tread depth, tire pressure, properly functioning slack adjusters, and brake pad thickness, as well as any visible issues with air or electrical lines under the trailer. Additionally, all locking pins and slider guides were inspected during this step.

Step 9: Students next moved on to the rear of the trailer, where they inspected the reflective material, aerodynamic devices (if present), and all rear-facing lights (marker, signal, brake, flashers, and tag). Cargo doors were inspected for proper working condition and attachment and ensured that the cargo was properly secured. The rear impact guard was also inspected to confirm it was within the more stringent enhanced inspection criteria:

- Not missing, loose, or broken.
- No cracked welds in the horizontal or vertical member or supporting structure or any attachment to vehicle structure.
- **The horizontal member is not bent inwards, downward, upward, or outward beyond 3 inches.** [Emphasis from original document.]
- The vertical supports and/or supporting structure is not weakened, bent, or distorted.

Step 10: Students performed an inspection of right trailer wheels, etc., following the same procedures as in Step 8.

Step 11: Students performed an inspection of the right side of the trailer body, etc. The procedure was the same as in Step 7 and added, if present, inspection of the spare tire storage device and that the tire is properly secured.

Step 12: Students performed an inspection of the rear tractor area, following the same procedure as in Step 6.

Step 13: Students performed an inspection of the right saddle tank (if present), following the same process as in Step 4.

Step 14: Students performed an inspection of the right front side of the tractor, with the same procedure as in Step 3.

Step 15: Students performed an inspection of the steering axle and surrounding components. This part of the inspection began with activating and confirming proper function of emergency flashers prior to opening the hood. Once the hood was open, students inspected several systems and components from both above and underneath via a creeper. These systems included:

- The steering system. This inspection included checks of the steering box and shaft, all nuts, bolts, clevis pins, fluid level, etc.
- The suspension system. This included nuts, U-bolts, shocks, shackles, leaf springs (none missing, cracked, or broken), airbags, etc.
- The front brake components. This included verification of brake chamber size, proper pad thickness, condition of the drums or rotors, etc.
- The front tires. This included a check of sidewall condition, tread depth (minimum of 4/32 in.), verification that no retreads were present, etc.

Step 16: Students (while still under the vehicle) moved on to inspect the drivetrain and axles 2 and/or 3. During this part of the inspection, they checked:

- The drive shaft, exhaust system, and air tanks to ensure all were in good condition and properly secured.
- The suspension and related components.
- The brake components (if needed; this includes scribing to determine chamber size).
- The frame condition and all items attached to it.
- Hazard lamps on the rear of the tractor.

Step 17: Students continued inspecting under the trailer (floor, frame, crossmembers, etc.) via a creeper as they worked their way back to axles 4 and/or 5. This included brake and suspension components and tire sidewall inspections, ending with the student exiting from under the rear of the trailer to confirm all hazard lights were properly functioning.

Step 18: During this step, students were required to demonstrate the ability to properly check brake adjustment. This began with the students ensuring air pressure was 90 to 120 psi. Students then used a supplied device (called a brake buddy) to apply and hold the service brakes. They then measured and recorded the pushrod travel (where applicable) and verified proper pad-to-drum contact. Students also listened for and identified the location/source of any air leaks and inspected the brake lamps on the tractor and trailer.

Step 19: Students next inspected the tractor protection system to ensure it worked properly. With the emergency brakes still released, the students disconnected both air lines from the trailer to ensure air stopped leaking from the lines before reaching 20 psi. Students also checked for any air pressure bleeding from the trailer itself. Students then fully applied the brakes to listen for any leakage from the gladhands prior to reconnecting them to the trailer.

Step 20: During this step of the inspection, students moved to the interior of the cab and inspected items such as the seat belts, sun visors, windshield, wipers (looking for damage or improper operation), and horn function. In addition to these items, the students checked the dashboard for warning lights, fault indicators for the ABS, and, if present, the electronic stability control. During the training class, all trucks were non-ADS-equipped vehicles; however, each student was trained that this would also be the point in the inspection when they would look for and indicate faults in the ADS if one were present. While in the cab, students also performed an air brake test. With the air pressure at 80 psi, students would apply the foot brake and look for air pressure loss. There could be losses of no more than 4 psi in the period of 1 minute or it would be considered a defect requiring repair.

Once the leak down test was completed, students then learned to start the tractor and push in the dash valves (wheel chocks were still in place for safety), and with the engine at idle, students would:

- Ensure the low-pressure warning activates by pumping the brake pedal to exhaust air.
- Build air up to 80 psi and verify gauge function. Continue building pressure to confirm it builds from 85 to 100 psi within 2 minutes and ensure the governor cuts out before 145 psi.
- Ensure brake pressure does not drop more than 20 psi per foot application.

Once the brake testing was completed, students moved on to checking for proper steering wheel lash, properly working tilt and telescopic features, and for damage to or improper function of the steering column. Students also verified the presence of safety triangles and fire extinguishers, the condition of the floor (free from holes), and finally, that the throttle, brake pedal defrosters, and heater all functioned properly.

Step 21: During Step 21, students demonstrated the ability to inspect both the fifth wheel and tractor parking brakes. Students removed the wheel chocks with the spring brakes set on the trailer. Students then placed the transmission in both drive and reverse to check for excessive play between the fifth wheel and the king pin. Students learned to properly mark and measure these components as needed to confirm excessive play. Students also released the trailer brakes and set the tractor parking brakes to confirm they properly worked as well.

Step 22: Students applied what they had learned in the classroom to properly verify that the trailer's payload was properly secured, blocked, and/or tied down as required.

Step 23: Students concluded the inspection process by properly completing the trip inspection report. For a "Dispatch Inspection," ALL defects are required to be both documented and fixed prior to the vehicle being released onto public highways. For "In-Transit Inspections," all defects

must be documented, and any qualifying defect that requires repair must be correct prior to release. All other lesser or non-safety critical defects that can be allowed to continue without immediate repair must be documented for repair prior to once again being "dispatched."

Hands-on training completion requires that the students achieve a minimum of 85% accuracy at the end of the inspection. Failure to locate, properly identify, and document at least 85% of the defects placed by instructor staff results in not completing the course and not receiving an inspector certification. Any student who is unable to pass would be required to complete the course again in its entirety and score 85% or higher. In addition to the inspector certification, CVSA does offer a certificate of course completion for those members of industry who wish to have a better understanding of the process from a more administrative perspective. This does not require a successful (or any) completion of the hands-on portion of the training. People who only obtain a certificate of course completion will not be permitted to perform a CMV enhanced inspections.

5.3.4.3 Electronic Communication of ADS Enhanced Inspection

As of August 2023, the following represents the current state of the electronic communication of an ADS enhanced inspection:

Electronic verification attached to the CVSA Enhanced CMV Inspection Program stands apart from other proposed and existing vehicle bypass and driver-focused messages such as a unique electronic identification (UEI) for CMVs and CVSA's Level VIII Electronic Inspection. UEI does not include information such as status of ADS equipment or ODD. UEI could serve a different function more akin to a vehicle registration for CMVs, whether operated by an ADS or human drivers. The CVSA Enhanced CMV Inspection is also not the same as CVSA's Level VIII Electronic Inspection, though the two could potentially be integrated in the future. Level VIII Inspections, as currently defined, focus on the status of human drivers and do not include hands-on vehicle inspection data.

During the summer of 2023, the Texas Department of Public Safety worked in partnership with Kodiak Robotics and Drivewyze to run a pilot of this program in order to learn more about the practicality and reliability of transmitting data between an ADS in motion and roadside monitoring stations.

During the test pilot, a series of trips were completed by ADS-equipped Kodiak Robotics trucks. As these trucks encountered designated inspection stations the following information was both transmitted and successfully received:

- Automated vehicle identification (identifies the vehicle as an AV)
- Inspection date
- Inspection time
- Inspection location
- Odometer reading
- Truck plate and jurisdiction on the enhanced inspection form

- Unit number
- Trailer license plate and jurisdiction
- Inspector name
- Defect status (whether the inspection was defect-free)

Per Drivewyze, and without disclosing proprietary information, "the screening aspects of the program, applied as the vehicle approaches the site, fall under the State Bypass Program." This is an important piece of key information as it makes it clear to both industry and enforcement that while there is a new level of inspection, at its most basic level it remains standardized and conforms to existing practices. As of this writing, the final data points to be transmitted have not been established.

5.3.5 Key Findings and Recommendations

Research on the effects of roadside inspections has shown a strong relationship between quality maintenance and inspection procedures and a decline in crashes related to vehicle defects. Mechanical failures appear to be a contributing factor in at least 10% of truck crashes. The failures most likely to cause crashes were those associated with brakes, tires/wheels, and lights. Additionally, research found that roadside inspections and application of the OOS criteria have significantly decreased the rate of truck crashes in which mechanical or safety defects were cited as a primary contributing factor. The efficacy of the periodic annual inspection is a little more uncertain. One study of CMVs suggested that the annual inspection was important for older vehicles and for identification of vehicles that were likely to have mechanical failures. This research suggested that the frequency of the periodic inspection needs to be increased, particularly for those systems (brakes, tires/wheels, and lights) that are more likely to contribute to crashes. ADS-equipped trucks may be subject to different types of inspection requirements than existing (non-ADS) trucks.

There are six existing truck inspection requirements: Pre-trip Inspection, Post-trip Inspection/DVIR, Roadside Inspection, Post-crash Inspection, Periodic Inspection, and Law Enforcement Inspection. In the pre-trip inspection, the driver is responsible for inspections, recognition, and decision-making tasks. Working with government and industry stakeholders, CVSA has developed an enhanced pre-trip inspection for ADS-equipped trucks. There is considerable support for an enhanced pre-trip inspection that considers both U.S. and Canadian inspection models. CVSA has determined that special credentials and training are needed for carrier inspectors of ADS-equipped CMVs. A determination on electronic communication of inspection elements is ongoing.

Currently, post-trip inspections are required. The basis for the DVIR is sound: the driver, who has driven the vehicle for as much as 11 hours, should be aware of any part of the vehicle that appears to be malfunctioning. The consensus of the interview with Federal and State employees was that the post-trip inspection/DVIR would no longer be needed for ADS-equipped CMVs. Given that an ADS-equipped truck is likely to be dispatched with "quick turnarounds," there is no need for both the pre-trip inspection and post-trip DVIR.

Inspectors were split on the idea of whether to conduct a Level I inspection roadside or a Level V inspection at an alternative site (i.e., carrier's terminal or transfer center). The inspectors who wanted to inspect ADS trucks at roadside felt that an ADS-equipped truck would have to be capable of responding to communications from roadside inspectors (where to stop, go, and park). Some inspectors raised safety concerns about inspecting ADS-equipped trucks without a safety operator or driver. Electronic communications will be important not only for government systems at roadside but for communicating between the ADS-equipped truck when picking up and dropping off loads at terminals or port facilities to verify the status of repair and maintenance at dispatch and in-transit locations.

Inspectors did not feel that any changes were necessary for the mechanical side of an ADS-equipped vehicle for post-crash inspections. They did, however, feel that a whole new set of inspection criteria would be needed to evaluate whether the ADS contributed to the crash. There was broad agreement among inspectors that the periodic inspection of ADS-equipped trucks would not be that much different than the inspections that are currently being conducted on similar vehicle classes today. Inspectors felt that ADS-equipped trucks were likely to be driven more miles per year and therefore should be inspected more frequently, possibly tying the periodic inspection to vehicle mileage. Additionally, inspectors suggested that at least one of the inspections should be conducted by a third party certified to conduct these types of mechanical inspections (i.e., a certified organization that does not benefit from the results of the inspection).

The National Institute of Justice, working with the RAND Corporation and the Police Executive Research Forum, developed an expert panel report on policing regarding ADS-equipped vehicles. This report identified four likely scenarios where law enforcement would likely interact with ADS-equipped trucks: traffic stops, collisions, emergencies, and tangential interactions. The expert panel report concluded that communications with the ADS-equipped truck will be one of the most important capabilities that largely does not exist today. One of the technical challenges of remote assistance is the lack of network coverage along major freight corridors. The deployment of 5G is not expected to be completed before 2025, and current network capabilities cannot always guarantee the bandwidth and latency requirements of remote assistance. Funding for U.S. infrastructure should help to expedite network coverage to rural America, particularly along highways.

In addition to these requirements, there is an Enhanced CMV Inspection that is not yet a requirement but is being accepted as a voluntary policy. It was designed with broad industry participation specifically for ADS-equipped trucks and addresses many of the considerations brought up in this paper. It is one significant part of the answer to the question of how to ensure the safety of ADS CMV operations. It is possible that this enhanced inspection will become a standard or requirement in the future.

The Enhanced CMV Inspection Program was designed to encompass requirements from both the U.S. and Canadian Inspection (Standard 13 of the NSC), and therefore it is already a strong candidate for a larger North American standard if that is something that is desired in the future. Many CMVs operate across borders, and, especially in a future with driverless trucks, there may be real benefit in implementing the Enhanced CMV Inspection Program across the entire North American continent.

5.3.5.1 Next Steps and Opportunities

Although there have been numerous advancements in the process to bring ADS technology to America's highways as highlighted throughout this document, there are still many more aspects of this process that must be determined. Some examples of discussions still ahead for the CVSA Enforcement and Industry Modernization committee are:

- Inspector Certifications
  - How frequently will classes need to be held in both the short and long term (initial rollout/long-term implementation)?
  - What will be the process for both recertifying as well as decertifying inspectors?
  - Would a "Train the Trainer" model be an acceptable option for recertifications?
- Enhanced Inspection Process
  - How will the Enhanced CMV Inspection Program Process impact the existing DVIR process for all inspections?
  - What changes to Federal regulations must be considered and how complicated might those changes be?
  - The current program works around a 24-hour clock:
    - When does the clock begin?
    - What happens should the vehicle be delayed due to traffic congestion, weather issues and compliance beyond the 24-hour window, and how should these delays be documented?
    - Would longer periods than 24 hours be accepted in special circumstances?
    - Can vehicles be inspected in advance and then staged in advance of an upcoming departure?
    - Is the vehicle still defect free if that inspection was greater than 24 hours prior to departure?
    - Can trucks and trailers be inspected separately as part of a staging process?
  - Record Keeping for Law Enforcement Inspections of Terminals.
    - A key component in the successful deployment and inspection of ADS commercial vehicles may include law enforcement in some form of accountability at the carrier or operator level.
    - Who maintains the records for review? How long? In what format/media?
    - Should there be a crosscheck or database established so that trends or common sources can be identified regarding failed enhanced inspections?
      - This trend analysis may be valuable, for example, not only in identifying common points of failure on ADS-equipped CMVs, but also identifying inspection stations that have an elevated number of failed inspections.
      - This trend analysis could also identify issues such as the need for remedial training or potentially identify inspectors or stations not following the enhanced inspection process in general. This could then relate back to the above work group question regarding decertification of an inspector as well as potential legal liability.

- Establishing criteria for both voluntary and random inspections of ADS-equipped vehicles by Law Enforcement.
- Determination of the weight of an unmanned ADS-equipped truck.
  - Will ports potentially be required to have a method of weighing trucks and trailers prior to releasing them to the highway?
  - Will CMV weight be transmitted to roadside monitors as part of an in-motion "inspection?"
  - Will CMV weight be accepted as the true and accurate weight, and what if there is a discrepancy during a weigh-in-motion screening?

These questions are a few key considerations that are active at the time of this report. As the industry continues to advance towards live integration of ADS-equipped CMVs into fleets and onto public highways, more challenges and discussions will be discovered.

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