



# CV/AV Needs Specific to Emergency Response White Paper

May 7, 2020



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### Introduction

Connected Vehicles (CV) and Automated Vehicles (AV) present a number of potential challenges and opportunities to emergency response and public safety. There is a need to educate local transportation and public safety agencies on the operations of CV/AV, and to support interactions between public safety emergency responders, transportation agencies, and vehicle manufacturers to identify potential response risks and opportunities of automation. Connected vehicle technology focuses on increasing safety through interoperable wireless communication between vehicles, with the infrastructure, and with other devices. Automated vehicle technology includes five levels of automated operational characteristics, with fully autonomous vehicles being a Level 5 (see Figure 1 below). Although connected and automated vehicles are separate technologies, they are developing in parallel and present some similar challenges and opportunities to transportation and public safety agencies.

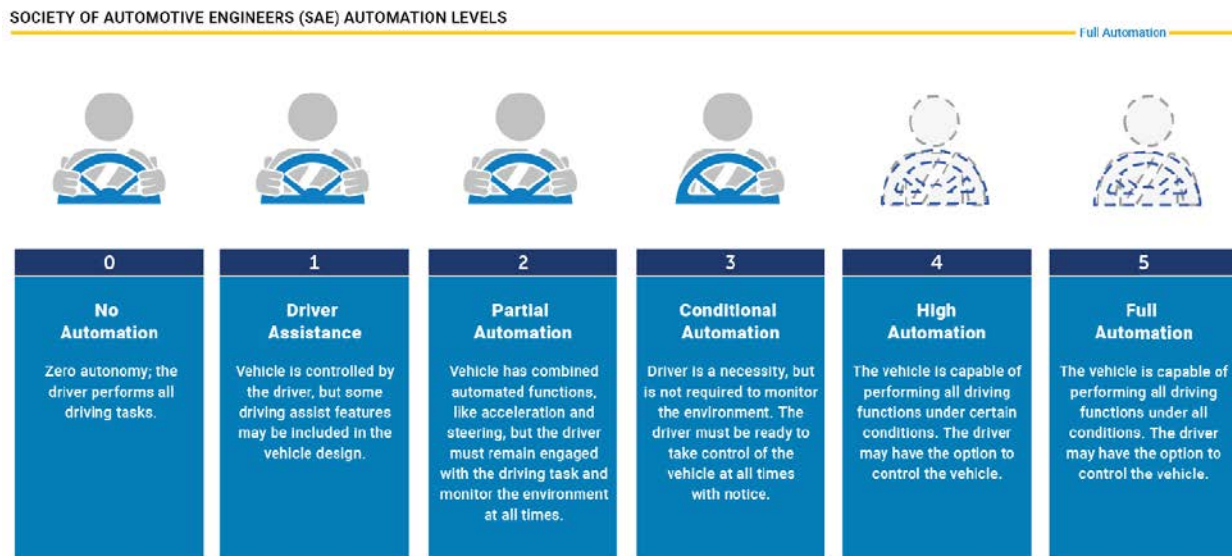


Figure 1: Levels of Automation

Source: FHWA Office of Operations

This paper discusses current research on CV/AV and the potential impacts of CV/AV on public safety emergency responders. It summarizes research being conducted in this area, including work being done by USDOT, NHTSA, and NCHRP, and identifies gaps in the current research and additional research needs.

### Overview of CV/AV Technology

CV/AV technology includes automated driving systems, connectivity, and system cooperation in an integrated vehicle roadway system. Connected vehicles (CV) include vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-everything (V2X) communications. This

communication serves as a basis for collecting and sharing information between a vehicle and its surroundings that can enhance safety and awareness of system conditions. For additional information on CV technology and public safety response, see TSAG publications on the *Connected Responder, Infrastructure to Responder (I2R)*, and *Advanced Automatic Collision Notification (AACN)*.

Automated vehicles (AV) include a range of levels of automation, shown in Figure 1 above, from no automation of driving functions to driver assistance and partial automation up to fully automated driving. At this time, new cars generally provide a number of driver assistance technologies, such as lane control, blind spot detection, emergency braking, and parking assistance. More advanced vehicles offer Level 2 partial automation. As vehicles become more automated, it is anticipated that the safety of drivers will increase as human error is removed from day-to-day driving.

Cooperative driving automation (CDA) brings together CV/AV technology into an integrated roadway system. CDA “enables automated vehicles (AVs) to communicate between vehicles, infrastructure devices, and road users such as pedestrians and cyclists... CDA also has the potential to reduce crashes caused by human error and save lives.” (FHWA, Cooperative Driving Automation)

A great deal of research has been and is being done on CV/AV technology and applications with a focus on the vehicle, the user, and the system. There has been very little focus on the implications of CV/AV on public safety emergency response and responders in the current and future CV/AV environment.

### **Current Research on CV/AV and Emergency Response**

USDOT is committed to researching, testing, and demonstrating connected vehicle technology to reduce injuries and deaths due to traffic crashes (there were more than 37,000 deaths from traffic crashes in 2018). CVs use communication technology to share information between vehicles, between vehicles and infrastructure, and between vehicles and other roadway users. (USDOT, How Connected Vehicles Work)

### **USDOT Automated Vehicles Activities**

USDOT is working to facilitate transportation innovation and safety, and to ensuring the U.S. remains a leader in automation. They have published three documents to support the development, testing, and integration of automated vehicle technologies: *Ensuring American Leadership in Automated Vehicle Technology*, *Preparing for the Future of Transportation*, *Automated Driving Systems 2.0*. These documents provide guidance on automated driving systems and outline the authorities, research, and investments made by the U.S. government to advance AV research, development, and integration. (USDOT, Automated Vehicle Activities)

### **USDOT ITS JPO**

The USDOT Connected Vehicle Pilot Deployment Program sponsored four CV pilots to spur innovations and encourage partnerships between public and private highway users and operators

to support a real-world assessment of CV concepts and technologies. Included in the safety applications considered in the pilots were emergency communications and evacuation information, collision warnings, collision avoidance systems, and other safety applications. The pilots did not look specifically at the interaction of CVs and public safety responders, with the exception of responding Highway Patrol vehicles in the Wyoming pilot project, where they looked at CV warnings related to adverse weather, work zones, and surface conditions. (USDOT, Connected Vehicle Pilot Deployment Program)

## FHWA Highway Automation Activities

### *FHWA National Dialogue on Highway Automation*

FHWA's recent National Dialogue on Highway Automation series was designed to engage a broad range of stakeholders to provide input. Stakeholders included original equipment manufacturers (OEM), technology suppliers, transportation network companies (TNC), associations, state and local agencies, and public sector partners. One of the five workshops focused on operations, including traffic incident management. One of the four key takeaways from the workshop was that "public safety officials require clear standard operating procedures for interacting with AVs.

Law enforcement, emergency responders, and the public safety community seek instruction on how to safely engage with AVs, especially since AVs are currently being tested on public roads and are operating with other road users. Workshop participants identified multiple instances where interactions with public safety officials or other roadway operators take place, including work zones and at the scene of an incident. Traffic simulation can assist with scenario planning and use case testing needed to understand these complex environments. Not every situation is predictable though. Participants identified the need for better understanding of the interaction of AVs with incident management processes and systems." (FHWA, National Dialogue on Highway Automation)

Additional research needs identified in the workshop included additional information on how law enforcement can pull over an AV, how to warn an AV to move out of the path of an emergency vehicle, how to ensure an AV will not leave the scene of a crash, and how to completely disable an AV.

### *FHWA Cooperative Driving Automation*

Cooperative driving automation (CDA) enables AVs to communicate between vehicles, the infrastructure, and road users to enhance efficiency and reduce crashes. CDA research focuses on how CVs and AVs can work together with the roadway infrastructure to increase safety and improve operations. One of the CDA research initiatives is CARMA, developed to enable testing and evaluation of cooperative automation concepts and applications. One of the CDA scenarios being studied is traffic incident management (TIM), looking at how CDA can enhance the safety and operations at incident scenes. The CARMA team has been collaborating with a TIM Working Group to develop TIM scenarios for testing. The first planned demonstration will be how CDAs respond when an emergency vehicle is parked on the shoulder and CDA observance of the move over law. (FHWA, Cooperative Driving Automation)

## AASHTO and NCHRP

The American Association of State Highway and Transportation Officials (AASHTO) and the National Cooperative Highway Research Program (NCHRP) have identified a number of research needs associated with CV/AV.

### *NCHRP 20-24(98)*

*The Connected/Automated Vehicle Research Roadmap for AASHTO*, NCHRP 20-24 (98), identified a list of unresolved issues related to CV/AV. The issues fell into four general categories: institutional and policy, infrastructure design and operations, planning, and modal applications. Within these categories, 20 research projects were identified. None of these projects specifically included the interaction of CV/AV with public safety emergency response and responders. (NCHRP 20-24(98))

### *NCHRP 20-102(16)*

*NCHRP 20-102(16): Preparing TIM Responders for Connected and Automated Vehicles* was approved as a research project in 2018. The purpose of the project is to consider how CV/AV technology will change how emergency responders and public safety personnel respond to crashes. The project will “investigate how traffic incidents change in a more connected transportation system and what the needs of traffic incident responders would be. A secondary objective is to describe how traffic incident responders should be included in the CV/AV research agenda moving forward.” This project is currently in development under the direction of the Transportation Research Board (TRB). (NCHRP 20-102(16))

### *Automation and Public Safety Common Solutions (APSCS)*

The APSCS Consortium, organized through CAMP LLC on cooperation with VTTI and UMassSafe, conducted the comprehensive study, *An Examination of Emergency Response Scenarios for ADS*, in 2018. The study included a literature search, consultations with subject matter experts, focus groups, and one-on-one interviews with public safety officials from fire, EMS, and law enforcement. They developed common scenarios in which public safety officials would interact with automated driving systems (ADS) and obtained feedback from responders on where there were knowledge gaps and differences in operational protocols to determine potential issues and benefits. The six operational scenarios developed for analysis were:

- Responding to an incident
- Securing a scene
- Traffic direction and control
- Traffic stops and checkpoints
- Abandoned or unattended vehicles
- Stabilization and extrication

They identified areas of additional information needs, including how:

- To disable a vehicle when securing the scene
- To investigate abandoned vehicles

- To stabilize a vehicle and perform extrication
- To know whether an ADS-equipped vehicle detects the presence of an emergency vehicle during response or conducting a traffic stop
- To direct an ADS-equipped vehicle while conducting traffic control at a scene
- The ADS-equipped vehicle will behave in advance of responding to these situations
- To identify ADS-equipped vehicles
- To determine who is responsible for the vehicle
- To obtain data from the vehicle

Participants in the focus groups and interviews also offered suggestions for additional scenarios. (CAMP LLC, 2018)

### TSAG Survey

TSAG recently conducted a survey, sent to the TSAG [Communities of Interest](#). The survey was designed to determine respondents' familiarity with and confidence in CV/AV technology. It also solicited input on concerns and anticipated benefits of CV/AV from a public safety response perspective. The survey was not scientific; rather, it was intended to solicit input and identify areas of needed research regarding CV/AV impacts on emergency response. Survey findings on the potential impacts and benefits are included in the next two sections. In addition to the discussion in these sections, it is important to note that even with the adoption and advancement of CV/AV in the general vehicle fleet, there is concern about the cost and timing of CV/AV in emergency response vehicles, which are costly to replace. A full summary of the survey responses to date can be found in Appendix A.

### Risks and Impacts of CV/AV on Emergency Response

A number of risks and impacts associated with CV/AV have been expressed by the public safety emergency response community. These include:

#### *Electrical hazards and ability to disable power*

Although not all CV/AV are electric or hybrid electric vehicles, many of the more advanced models are using these technologies. It is important that responders have access to a "kill switch" or have clear protocols for disabling the power to reduce electrical hazards and ensure that the vehicle does not move.

#### *AV's ability to detect and respond safely to emergency scene traffic control*

A common concern is whether vehicles driving under partial or full automation will respond safely and appropriately to on-scene traffic control at an incident. This includes temporary traffic control devices as well as human traffic control operations.

#### *AV's ability to detect and respond appropriately to response vehicles with lights and sirens*

How an automated vehicle responds to vehicles in emergency mode is not fully understood by responders. There is little confidence that AV's will respond by pulling over and yielding right of way to the emergency vehicle.

### *Compliance with move-over laws*

Move-over laws require vehicles traveling in the lane adjacent to response vehicles with lights on to move over or slow down when passing the vehicle. It is unclear how AVs will respond and react in these situations.

### *AV actions when there is an operational issue*

There is a question about how AVs will respond to a vehicle operational or mechanical issue – will they pull to the side of the road, attempt to exit the highway, or simply stop in a lane creating a hazard?

### *Emergency access for patient care and extrication*

It is important to understand how CV/AV will impact responders' access to patients within vehicles to facilitate safe and timely patient care and extrication.

### *Stabilizing vehicles and disabling self-drive mode*

There is concern with how to stabilize and disable CV/AV to ensure responder and patient safety.

### *Ability to communicate with vehicle system operator*

CV/AV that function in a system environment, such as higher-level automated vehicles, have system operators who can support responders in disabling vehicles and responding to emergencies. How responders communicate with the operators is not well understood.

### *Preservation of on-board event data*

CV/AV on-board data can provide important safety information in the event of an incident and assist in response and crash reporting functions. Concerns with how this data is preserved and how it can be accessed have been expressed.

### *Vehicle towing requirements*

Towing requirements for CV/AV are not well understood. If these are different from current towing requirements, they need to be defined and coordinated with towing service providers.

### *Additional training for public safety responders*

It is important to define all additional training requirements for responding to CV/AV incidents and develop additional training resources to support public safety agencies and responders to meet these training needs.

USDOT encourages automated vehicle developers to engage with the first responder community when developing and testing technologies to identify new applications that can enhance emergency response. They also suggest working with first responders to educate, raise awareness, and develop emergency response protocols.

An example of where this is happening is with Waymo. Waymo is building self-driving cars currently being tested in Chandler, AZ. They are working closely with the Chandler Police and Fire

Departments to address safety concerns. They have developed a *Waymo First Responder Guide* video and *Emergency Response Guide and Law Enforcement Interaction Protocol*, and provide hands-on training for responders to familiarize them with their electric hybrid, self-driving vehicles.

#### *TSAG recommendation*

More research and discussions need to occur at the national level to understand the implications of emergency response concerns and develop applications and protocols to ensure safe and effective emergency response to incidents involving CV/AV.

### **Opportunities for Enhanced Safety of Emergency Response with CV/AV**

The National Highway Traffic Safety Administration (NHTSA) has identified four areas of benefit from vehicle automation: safety, economic and societal, efficiency and convenience, and mobility. In terms of safety, they note that automated vehicles have the potential to “save lives and reduce injuries” because “94% of serious crashes are due to human error. Automated vehicles have the potential to remove human error from the crash equation.” (NHTSA, Automated Vehicles for Safety) Connected vehicles can also increase responder safety by allowing safer travel to the response scene and providing additional information en route and on scene. (TSAG, Connected Responder, 2016, and Infrastructure to Responder (I2R), 2019)

#### *Enhanced and automated crash notification*

CV technology allows for automated collision notification which provides responders with quicker notification, crash location, and crash severity information.

#### *Enhanced crash data*

CV can provide information to responders to enhance their response, provide them with situational awareness to improve their safety, and support faster and more detailed crash investigation and reporting.

#### *Reduced response times*

CV can notify public safety answering points (PSAP) faster than those involved in or passing a crash. This reduces notification times and supports faster response.

#### *Improved patient outcomes*

Faster response and treatment result in improved patient outcomes.

#### *Reduction in number of crashes*

AV are anticipated to significantly reduce vehicle crashes by minimizing or removing human error in driving.

#### *Reduction in severity of crashes*

CV/AV technology can reduce the severity of crashes at all levels of automation and connectivity, including hazard warnings, emergency braking, and vehicle cooperation.



#### *Ability to geofence an incident scene to reduce vehicle intrusion*

With CV/AV, the opportunity exists to geofence an incident scene to keep vehicles from entering and enhance scene safety.

#### *Automated, cooperative lane change (move-over and lane shifts)*

Beyond moving over to yield to emergency vehicles with lights and sirens, CV/AV can work cooperatively to move out of the way creating virtual emergency lanes.

#### *Safer response*

CV can enhance the safety of response vehicles en route to a scene by supporting signal preemption and information about response routes. On scene, CV can support enhanced situational awareness through information available through digital feeds.

Research conducted by Austin W. Obenauf and others looked at a number of these benefits. They considered emergency response times and the potential benefit of using virtual emergency lanes automatically, eliminating human indecision and error. They used local response data to model the effectiveness of virtual emergency lanes under three levels of connected and automated vehicle CAV scenarios: 0%, 50%, and 100% and under varying roadway configurations. They found significant response time savings that increased with CAV market penetration. In addition to the response time savings with CAV technology, they also determined that connectivity (V2I) can reduce response time as well. (Obenauf et.al, 2019)

#### *TSAG recommendation*

Additional research focused on how CV/AV can enhance and support public safety response is needed to advance the understanding and acceptance of CV/AV technology by emergency responders. This research should go beyond the traditional focus on user safety to specifically examine issues related to incidents and incident response.

### **CV/AV Research Needs Related to Emergency Response**

FHWA cooperative automation research is mainly focused on platooning, speed harmonization, lane changing, and other vehicle-to-vehicle and vehicle-to-infrastructure communications. The focus is on driver, user, infrastructure, communication, and cybersecurity with little attention to emergency response and responders. Some attention has been given to law enforcement and how vehicles will respond to traffic laws and to law enforcement officers. A few examples of how CV/AV will impact first responders have been considered, including how CV/AV will respond to vehicles running with lights and sirens, or to temporary traffic control and responders at the scene of an incident.

#### *TSAG recommendation*

To date, the safety benefits being considered for CV/AV generally focus on users (reducing human error, driver distraction, crash and injury severity), pedestrians, and bicyclists. There is currently little structured research that looks at the potential impacts to emergency response and responder safety. TSAG recommends that this become a research priority at the Federal and State level to

address the range of concerns and issues identified here, conduct demonstrations and pilot programs focused on emergency response, and advance and support the benefits of CV/AV to emergency response.

## **CV/AV and Emergency Response Use Cases**

In a roadway system in which vehicles are fully connected, cooperative, and automated, a highway incident would function differently than it does today. The following scenarios highlight some of the changes that may occur under a fully automated fleet scenario and a partially automated, mixed fleet scenario.

### *Fully Automated Fleet*

A rock slide has occurred on a rural highway with one involved vehicle. The AACN system in the vehicle sent the location and extent of damage report to the local PSAP. Based on the speed of travel of the vehicle at the time of impact and the registered level of damage to the vehicle, the notification indicated the potential for severe injury. As fire, EMS, and law enforcement respond to the scene, vehicles on the highway respond to the presence of emergency vehicles by automatically and cooperatively moving out of the way to form a virtual emergency lane, allowing a quick response to the scene. At signalized intersections, signals are preempted and right of way is given to emergency response vehicles. On scene, the involved vehicle notifies the responders of any vehicle hazards, provides information on how to safely approach and disable the vehicle, and sends additional safety information associated with extrication, as the roof of the vehicle is partially crushed. Incident command is able to set up a geofence around the incident scene to keep vehicles from entering the area. The establishment of a geofenced area automatically updates system information to redirect approaching vehicles onto alternate routes. Upstream vehicles receive speed control messages to automatically slow traffic approaching the incident scene. Vehicle data for one minute prior to impact is sent to the responding law enforcement data system to aid in crash reporting.

### *Partially Automated Fleet*

A 1985 pickup truck has struck an automated passenger car at an urban intersection. The automated vehicle notifies the local PSAP that it has been struck and provides location and vehicle telemetric information. Responding to the crash, fire, EMS, and law enforcement interact with mixed levels of automation and mixed responses to their lights and sirens. CV/AV vehicles respond more quickly and more predictably than older vehicles with no automation, to allow the emergency vehicles to pass. Upon arrival, responders find the passengers out of both vehicles and a Level 3 automated vehicle on fire. The involved vehicle is fully electric and based on current protocols and previous training the firefighters know to treat this as they would other vehicle fires, with extra attention to keeping the vehicle battery cool.

### *Use Case Takeaways*

It will be some time before the vehicle fleet is fully automated. As CV/AV are accepted and mixed into the vehicle fleet, emergency responders should expect that drivers will continue to behave in unpredictable ways as they respond to the scene emergent. There will be variation in the information provided depending on the level of technology and application of AACN. New

challenges will be presented by changes in protocols and safety precautions associated with increasingly automated and increasingly electrified vehicles. Through enhanced collaboration between the public safety community, vehicle manufacturers, technology providers, and government agencies, many of the beneficial aspects of automation can be advanced while minimizing the negative impacts of CV/AV on emergency response.

## Resources

AAMVA, [Jurisdictional Guidelines for the Safe Testing and Deployment of Highly Automated Vehicles](#), 2018

CAMP LLC, [An Examination of Emergency Response Scenarios for ADS, Final Report](#), 2018

FHWA, [Automated Vehicle Activities and Resources](#)

FHWA, [Cooperative Driving Automation](#)

FHWA, [National Dialogue on Highway Automation: October 24-25, 2018 Operations Workshop Summary](#)

GHSA [Automated Vehicle Safety Expert Panel: Engaging Drivers and Law Enforcement](#), August 2019

MnDOT, [CAV Scenario Planning Report](#), 2019

NCHRP, [NCHRP 20-102\(16\) \[Anticipated\]: Preparing TIM Responders for Connected Vehicles and Automated Vehicles](#)

NCHRP, [NCHRP 20-24\(98\): Connected/Automated Vehicle Research Roadmap for AASHTO](#)

NHTSA, [Automated Vehicles for Safety](#)

Obenauf, Austin W., et.al., [Impact of Self-driving and Connected Vehicles on Emergency Response: The Case of the USA and Implications for Italy](#), 2019

TSAG, [Advanced Automatic Collision Notification \(AACN\)](#), 2019

TSAG, [Connected Responder](#), 2016

TSAG, [Infrastructure to Responder \(I2R\)](#), 2019

US Congressional Research Service, [Issues in Autonomous Vehicle Testing and Deployment](#), February 2020

USDOT ITS JPO, [Connected Vehicle Pilot Deployment Program](#)

USDOT ITS JPO, [Intelligent Transportation Systems Joint Program Office Strategic Plan 2020-2025](#)

USDOT, [Automated Vehicles Activities](#)

USDOT, [CARMA Webinar Series: Creating a ConOps for CAV Freeway Applications](#), 2020

USDOT, [How Connected Vehicles Work](#)

Waymo, [First Responder Guide Video](#)

Waymo, [Fully Self-Driving Chrysler Pacifica Emergency Response Guide and Law Enforcement Interaction Protocol](#)

## Appendix

### TSAG Communities of Interest Survey Results

Responses as of 4-8-2020

#### 1. What TSAG Community of Interest do you represent?

Answer Choices	Responses	
Emergency Communications	6.45%	2
Law Enforcement	3.23%	1
Emergency Medical Services (EMS)	6.45%	2
Fire and Rescue	3.23%	1
Transportation Operations	16.13%	5
Emergency Management	3.23%	1
Technology and Telematics	16.13%	5
Academic and Research	22.58%	7
Governing Agencies	22.58%	7
	<b>Answered</b>	<b>31</b>

#### 2. How familiar are you with CAV technology?

Answer Choices	Responses	
Extremely familiar	31.25%	10
Very familiar	43.75%	14
Somewhat familiar	18.75%	6
Not so familiar	3.13%	1
Not at all familiar	3.13%	1
	<b>Answered</b>	<b>32</b>

#### 3. How confident are you that CAV manufacturers are considering potential impacts on public safety response?

Answer Choices	Responses	
Extremely confident	15.63%	5
Very confident	21.88%	7
Somewhat confident	31.25%	10
Not so confident	28.13%	9
Not at all confident	3.13%	1
	<b>Answered</b>	<b>32</b>

#### 4. What are your biggest response concerns with CAV technology?

Answer Choices	Responses	
Electrical hazards and ability to disable power	6.25%	2
AV's ability to detect and respond safely to emergency scene traffic control	71.88%	23
AV's ability to detect and respond appropriately to response vehicles with lights and sirens	65.63%	21

AV's response to emergency vehicles with lights on the side of the road (i.e. compliance with move-over laws)	53.13%	17
AV's actions when there is an operational issue (e.g. pull to the side or exit the highway)	50.00%	16
Emergency access for patient care and extrication	15.63%	5
Stabilizing vehicles and disabling self-drive mode	31.25%	10
Ability to communicate with vehicle system operator	18.75%	6
Preservation of on-board event data	12.50%	4
Vehicle towing requirements	12.50%	4
Additional training for public safety responders	31.25%	10
Other (please specify)	31.25%	10
	<b>Answered</b>	<b>32</b>

Other:

- All of above.
- Privacy and not using the system for law enforcement purposes (reduces CAV adoption rate)
- Safety is always the 1st concern but certification of the AV including after market components & installation.
- Distracted Driver's. Too much confidence in the vehicle's technological abilities that the driver doesn't pay attention nor drive the vehicle or the driver is taken completely out of the loop (example, 737MAX software liabilities). Vehicle software not tested adequately.
- CAV technology that can be retrofitted into emergency vehicles given the typical fleet age and low replacement rate.
- Compliance with Move Over laws.
- The ability to receive Digital Alerts. Car companies seem to be trying to use acoustics, rather than Digital Alerts.
- How human operators will safely operate automated vehicle technology
- How do responders know when they are responding to an accident that involves a CAV?
- Ability to respond in the event of power or network connectivity disruption. Also - coverage is an issue - especially in urban canyons and and remote rural areas.

**5. What benefits to public safety do you anticipate from CAV technology?**

Answer Choices	Responses	
Enhanced and automated crash notification	59.38%	19
Enhanced crash data	46.88%	15
Reduced response times	43.75%	14
Improved patient outcomes	31.25%	10
Reduction in number of crashes	71.88%	23
Reduction in severity of crashes	65.63%	21
Ability to geofence an incident scene to reduce vehicle intrusion	31.25%	10
Automated, cooperative lane change (move-over and lane shifts)	37.50%	12

Other (please specify)	6.25%	2
	<b>Answered</b>	<b>32</b>

Other:

- Enhanced connectivity and communication between emergency vehicles and regular motorists.
- Enhanced emergency location information

### 6. What changes do you anticipate in your agencies to meet the demands of CAV?

Answer Choices	Responses	
Changes to agency protocols	53.13%	17
Additional training needs	71.88%	23
New equipment needs	53.13%	17
Other (please specify)	21.88%	7
	<b>Answered</b>	<b>32</b>

Other:

- New enforcement and pti procedures
- We represent organizations that will be impacted.
- Development of Codes & Standards
- While not a first responder agency, I suspect all of these changes will need to be considered.
- None
- Improved laws and regulatory frameworks.
- Access to information such as ability to quickly disable from remote sites that are not the CAV's host, i.e. 911 centers and first responders at a scene.

### 7. What information or additional research do you need to support response to CAV?

**Answered** **12**

- How much does CV reduce response time?  
Compared to other systems?  
Does CV reduce accidents or reduce severity of accidents for first responders?
- Needs and expectations of the public safety / first responders community.
- Working Group participation of stakeholders in the development of a bi-national CAV Code initiated by CSA Group.
- Standard protocols across manufacturers for disabling and towing systems and standard behaviour responses to 1st responder commands.
- Need standards, protocols, testing and pilots for products that would alert the traveling public (AV or not) to approaching EV's and/or EV's and personnel positioned at the event scene.

- Weather related changes and operation
- Determination of mechanisms by which passenger vehicle owners can "opt" to allow their telematics device to transmit data to enable estimates of probability of serious injury Technology that "talks" to inbound emergency responders about hazards present in the vehicle (airbags that should have deployed but didn't, leaking fuel tank, charged electrical system, etc.)  
V2V technology for LE and EMS to exchange a GUID in order to facilitate deterministic records linkage
- What does the vehicle do when interference causes incomplete or invalid data?
- I have to keep myself updated with their operational procedures improvements.
- Training for law enforcement and first responders on what to expect from automated vehicle technology
- We need to better understand the technology. Under what conditions does it work well and under what conditions does it struggle? What is the anticipated loss of jobs in the transportation industry? What is the anticipated training required for displaced workers?
- More information on back-up systems, overrides, and remote functionality.

**8. What publications or resources should we include in the literature review for this project?**

**Answered**

**8**

- Standards (this isn't an area listed in 1 above)
- Suggest looking at various publications from Transport Canada
- CAMP-sponsored research (<https://www.vtti.vt.edu/featured/?p=1088>); Automated Vehicle Safety Consortium best practice
- Try to get actual field experience reports - not all simulations!
- FirstNet
- Keep an eye on the international innovative ideas being shared by the Global experts to refurbish them as per needs to keep CAV sustainable in our community.
- Not sure.
- Lessons learned and documentation on worst-case-scenario testing.