
# An Examination of Emergency Response Scenarios for ADS

**Final Report**

**October 2018**

Terry, T., Trimble, T. E., Blanco, M., Fitzgerald, K. E., Fitchett, V. L., and Chaka, M. (2018). An Examination of Emergency Response Scenarios for ADS. Farmington Hills, MI: Crash Avoidance Metrics Partners LLC.

# Executive Summary

In the future, vehicles equipped with automated driving systems (ADS) that drive us instead of us driving them will become a reality. These vehicles will integrate onto roadways and may change operational interactions with other vehicles in certain scenarios. Public safety officials, such as law enforcement, fire and rescue, and emergency medical personnel routinely interact with a broad spectrum of public and private vehicles to protect people, to investigate crimes or crashes, and to save lives. This research effort sought to determine the following:

- What are the common scenarios where public safety officials must engage in several different interactions and interaction types with a broad spectrum of public and private vehicles?
- What are the protocols used during those scenarios and the different interactions and interaction types?
- Do variables such as weather, roadway type, geometry, or vehicle type impact current protocols used in those scenarios?
- How may the current operations change due to the introduction of ADS-equipped vehicles in driverless operation (DO)?
- Are there opportunities where the interactions of public safety officials could be improved with the introduction of ADS-equipped vehicles in DO?

An extensive review of available literature and consultations with subject matter experts allowed the research team to determine the most common scenarios where public safety officials interact with other vehicles. Those scenarios included responding to an incident, securing an incident scene, conducting traffic direction and control, conducting a traffic stop, investigating an abandoned or unattended vehicle, and performing stabilization and patient extrication. Each of these operations were broken down task-by-task using a Hierarchical Task Analysis (HTA). The HTAs were converted into task diagrams to illustrate the procedures.

A combined effort between the Virginia Tech Transportation Institute (VTTI) and the University of Massachusetts Traffic Safety Research Program (UMassSafe), a division of the UMass Transportation Center (UMTC), conducted focus groups and one-on-one interviews with a total of 79 public safety officials. The participants were law enforcement, fire and rescue, and

emergency medical services (EMS) personnel from 22 different U.S. states and 3 Canadian provinces.

In the interviews and focus groups, the research teams showed the participants three of the six different scenarios and posed questions regarding how accurate the research team's depictions of the operations in the videos were. These responses allowed the research team to fill in any gaps in knowledge or highlight any potential differences in operations that may exist depending on department size, department type, or geographical region.

In the final portion of each interview, the research team showed a video that introduced participants to the idea of ADS-equipped vehicles in DO (referred to in the focus groups and interviews as vehicles equipped with automation in driverless mode). Subsequent questions focused on the scenarios the groups had previously discussed, and they were asked how the advent of those systems might change their current procedures. Responses were typically provided in the form of questions or hypotheticals. Much of the feedback provided allowed the research team to deduce the suggested needs of public safety officials as well as potential opportunities for the technology to benefit their current procedures. Each interview closed with questions regarding which scenario may be afforded the greatest opportunity for improvement when considering ADS-equipped vehicles in DO as well as the extent of their experience with vehicles that are currently sometimes referred to as "autonomous."

The recorded interviews were transcribed and then placed in worksheets, so themes could be coded. Responses were placed in "bins" that correlated with a specific theme or idea. Each theme or idea was then associated with an interaction type: direct, indirect, or informational. Direct interactions involve a physical interaction between a public safety official and a vehicle either by touching it or using a tool to touch it. Indirect interactions are when a public safety official manipulates a vehicle, or driver, without coming into contact with a vehicle. Informational interactions are when public safety officials gather information from a vehicle or driver either by observing it, searching around it, or requesting it.

The most common responses included the following interaction types, themes, and associated number of responses, indicated in the parenthesis.

**Direct Interaction: Represented the need to know "How to…"**

- Disable the vehicle when securing an incident scene (38), investigate an abandoned vehicle (4), or perform stabilization or extrication (4)

**Indirect Interactions: Represented the need to know "How to…"**

- Know that the ADS-equipped vehicle has sensed or detected the presence of emergency vehicles during an incident response (16) or when conducting a traffic stop (19)
- Signal or communicate to the vehicle when conducting traffic direction and control (39) or securing an incident scene (5)

**Informational Interactions: Represented additional "Need to know how…"**

- The vehicle will react or behave in advance of responding to an incident (30), conducting traffic direction and control (17), or investigating an abandoned vehicle (4)
- To identify or determine a vehicle is an ADS-equipped vehicle in DO when responding to an incident (22), conducting traffic direction and control (14), conducting a traffic stop (11), securing an incident scene (7), or investigating an abandoned vehicle (6)
- To determine who is responsible for the vehicle when securing an incident scene (23) or conducting a traffic stop (20)
- To obtain various data from the vehicle prior to its involvement in an incident being secured (23) or the initiation of a traffic stop (2)

The participant feedback indicates several potential opportunities for improved interactions between public officials and future ADS-equipped vehicles in DO. Consistent actions by vehicles in all the scenarios was said to largely benefit the safety and efficiency of public safety officials. Additional technologies that were speculated to be associated with these vehicles, such as mass communication capabilities to warn other vehicles and detailed data of the vehicle's behavior prior to an incident or traffic stop, were all mentioned as strong positives for resources, time, and safety. The responses garnered from the interviews conducted with public safety officials were stated inquisitively as needs but are opportunities for additional research efforts to investigate further.

The objectives of this research effort were to:

- Determine common public safety scenarios through a literature review and subject matter expert opinions
- Use an HTA to analyze and breakdown the tasks of each scenario step-by-step
- Verify that the safety scenarios are complete by requesting further subject matter expert opinion via focus groups and interviews
- Inquire how introduction of ADS-equipped vehicles in DO may change current procedures conducted in each scenario
- Determine opportunities where the interactions of public safety officials could be improved with the introduction of ADS-equipped vehicles in DO

The steps taken to accomplish these objectives will be the focus of this document:

- Chapter 2 describes the research methods associated with the project tasks, including the literature review, HTA, and DO needs assessment.
- Chapter 3 provides additional details on the DO needs assessment data analysis efforts.
- Chapter 4 presents the literature review and HTA.
- Chapter 5 discusses of the DO needs assessment findings for each operational scenario.
- Chapter 6 summarizes to key findings from the DO participant feedback assessment key findings.
- Chapter 7 draws attention to potential opportunities for improved operational procedures and interactions moving forward.

# Acknowledgements

This study is based on a research project funded and led by the Automation and Public Safety Common Solutions (APSCS) Consortium organized through CAMP LLC, with technical work completed by VTTI and UMassSafe. The authors would like to recognize the APSCS team, including Principal Investigator Chuck Green (General Motors), Ed Bradley (Toyota), Roy Goudy (Nissan), Doug Longhitano (Honda), Ed Thai (Hyundai), Gurunath Vemulakonda (Ford), Barbara Wendling (Mercedes-Benz), and thank the UMassSafe team for its invaluable input and data collection efforts. Appreciation is also due to VTTI personnel who completed the focus group and interview portions of the study and those who led recruiting efforts.

# Table of Contents

# List of Figures

# List of Tables

# Chapter 1: Introduction

As Automated Driving System (ADS) technology continues to progress, the role of the human driver changes ranges from a driver to a fallback-ready user or a passenger. In vehicles with higher levels of automation, such as vehicles utilizing systems described by SAE International as level 4 or level 5 (SAE International, 2018), there may be no human driver or fallback-ready user present. The integration of ADS-equipped vehicles in driverless operation (DO) into the vehicle fleet alongside current conventional vehicles may present opportunities to improve interactions with governmental and public safety agencies. These opportunities may be identified in how public safety officials modify their interactions to adapt to the introduction of ADS-equipped vehicles. For instance, if a police officer witnesses an unattended ADS-equipped vehicle in DO in a no-parking zone, as opposed to towing the vehicle or looking in the nearby area for an owner, the police officer may use the license plate information to determine the next steps for interacting with the vehicle's owner. As indicated in Davis (2016), public safety agencies expect that their interactions with ADS-equipped vehicles will be impacted, whether directly through physical contact with these vehicles or indirectly in the way that they have to alert nearby vehicles to yield to them during an emergency response. Interactions with conventional vehicles include interactions with the human driver, but for the purpose of this research effort, the focus of the interactions of interest are with the vehicle.

From a technical perspective, ADSs are subject to rigorous testing of all aspects of their environmental interactions, including interactions with the roadway, pedestrians, and potential hazards. However, little research has been conducted to determine the types of interactions public safety authorities may be required to have with ADS-equipped vehicles in DO. This research seeks to determine the types of interactions that public safety authorities, such as police, fire fighters, and emergency medical personnel, currently have with vehicles and to break down those interactions through a detailed task analysis. In addition, the research was intended to gather information on the operations and expected behaviors of public safety authorities so that any potential opportunities to improve these interactions for ADS-equipped vehicles may be identified for further investigation.

Currently, no existing resource or the research literature provides a complete task breakdown of interactions between public safety authorities and vehicles. At best, traffic enforcement manuals exist for a number of cities that establish general tasks or guidelines associated with some duties; however, many duties require discretion or on-site training and are not outlined in any comprehensive literature. Training materials likely have the most in-depth information, though it is common practice to rely on instructors to demonstrate and present the materials rather than explaining them in writing. The bulk of the information provided in this document is gathered from individual department policies and personal communications. Across the three public safety domains of interest for this research effort—law enforcement, fire and rescue, and emergency medical services (EMS)—very little standardization exists, even between departments within the same agency. Manuals and training documentation provide general guidelines, but many differences exist in the culture, attitudes, and norms that influence how public safety authorities make operational decisions.

## 1.1 Public Safety Definition

For the purposes of this research, the term "public safety" refers to law enforcement, fire and rescue, and EMS. Not included in the scope of this research are private companies, organizations, or individuals such as tow operators. Public safety is a broad concept that can extend beyond the work of law enforcement and first responders (which includes the Department of Homeland Security [DHS]; the Federal Bureau of Investigation [FBI]; the Bureau of Alcohol, Tobacco, Firearms, and Explosives [ATF]; the U.S. Marshals Service; and other agencies) to encompass the domains of border control officers, traffic enforcement personnel, and fire services. Public safety organizations exist at multiple levels of government and often have overlapping goals and jurisdictions. For instance, law enforcement officers and their associated processes are spread out among state, county, city, and municipal jurisdictions. Entities such as fusion centers, parking authorities, commercial vehicle enforcement agencies, security firms, and area evacuations personnel are not considered here.

## 1.2 Automated Driving Systems (ADSs)

In June 2018, SAE International released the latest Recommended Practice titled Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles (Table 1), which presents the appropriate terms and definitions used to describe driving

automation system technologies (SAE J3016_201806, SAE International 2018). There are six levels of driving automation, ranging from level 0 to level 5. Level 0 describes a system that has *no driving automation,* whereas level 5 refers to a system that provides *full driving automation*. Driving automation system level is defined by the driving automation features engaged and their interaction with the dynamic driving task (DDT) in addition to the level at which the system can complete object and event detection and response (OEDR). The need for a DDT fallback is also part of the considerations for the taxonomy (SAE International, 2018).

An ADS is defined as the hardware and software that are collectively capable of performing the entire DDT on a sustained basis. This holds true regardless of whether the system operation is relegated to a specific operational design domain (ODD), such as a specific road type or geographical area. The term ADS applies specifically to SAE levels 3, 4, and 5 (SAE International, 2018).

An ADS-equipped vehicle is considered to be in DO when either there is no onboard user present or when onboard users are not drivers or fallback-ready users. A fallback-ready user is a user of a vehicle with an engaged level 3 ADS feature who is able to operate the vehicle if the ADS issues a request for the user to intervene. Level 4 and 5 ADSs do not require a fallback-ready user to be available; the system will perform any DDT fallback and achieve a minimal risk condition as needed. For DO, passengers are not considered fallback-ready users, but are rather defined as users of the vehicle who have no role in its operation (SAE International, 2018).

A vehicle designed to require a human driver during at least part of a trip is considered a conventional vehicle. This is true even if a vehicle contains level 3 ADS features to complete the DDT for a portion of the trip. A vehicle is only considered an ADS-dedicated vehicle (ADS-DV) when the vehicle is designed to be operated exclusively by a level 4 or 5 ADS for all trips. Some vehicles may be designed to perform complete trips in DO or with a conventional driver. These vehicles are termed ADS-equipped dual-mode vehicles (SAE International, 2018).

**Table 1. Summary of Levels of Driving Automation (Source: SAE International J3016_201806).**

| Level | Name | Narrative definition | DDT | | DDT fallback | ODD |
|---|---|---|---|---|---|---|
| | | | Sustained lateral and longitudinal vehicle motion control | OEDR | | |
| **Driver performs part or all of the DDT** | | | | | | |
| 0 | No Driving Automation | The performance by the driver of the entire DDT, even when enhanced by active safety systems. | Driver | Driver | Driver | n/a |
| 1 | Driver Assistance | The sustained and ODD-specific execution by a driving automation system of either the lateral or the longitudinal vehicle motion control subtask of the DDT (but not both simultaneously) with the expectation that the driver performs the remainder of the DDT. | Driver and System | Driver | Driver | Limited |
| 2 | Partial Driving Automation | The sustained and ODD-specific execution by a driving automation system of both the lateral and longitudinal vehicle motion control subtasks of the DDT with the expectation that the driver completes the OEDR subtask and supervises the driving automation system. | System | Driver | Driver | Limited |
| **ADS ("System") performs the entire DDT (while engaged)** | | | System | System | Fallback-ready user (becomes the driver during fallback) | Limited |
| 3 | Conditional Driving Automation | The sustained and ODD-specific performance by an ADS of the entire DDT with the expectation that the DDT fallback-ready user is receptive to ADS-issued requests to intervene, as well as to DDT performance- relevant system failures in other vehicle systems, and will respond appropriately. | | | | |
| 4 | High Driving Automation | The sustained and ODD-specific performance by an ADS of the entire DDT and DDT fallback without any expectation that a user will respond to a request to intervene. | System | System | System | Limited |
| 5 | Full Driving Automation | The sustained and unconditional (i.e., not ODD- specific) performance by an ADS of the entire DDT and DDT fallback without any expectation that a user will respond to a request to intervene. | System | System | System | Unlimited |

## 1.3 Best Practices and Guides for ADS

Considerations for law enforcement as they relate to ADS deployment have centered on thorough reporting of all ADS-related incidents for the purposes of accurate statistics and establishing liability. The Model Minimum Uniform Crash Criteria (MMUCC) has been updated as of August 2017 to include guidance for recording ADS data on crash reports and includes SAE definitions. The crash report template provides new fields for law enforcement to specify the vehicle's ADS capabilities and the driving automation engaged at the time of the crash (NHTSA, 2017).

In 2018, the National Highway Traffic Safety Administration (NHTSA) reiterated best practices for legislatures and state highway officials regarding ADSs. NHTSA proposes that states consider training public safety authorities in conjunction with ADS deployments to improve the knowledge and understanding of ADS-equipped vehicles and potential interactions. NHTSA also suggests that coordination among states would assist in expanding the knowledge and expectations for human driver behavior when interacting with an ADS-equipped vehicle (NHTSA, 2018).

There have been some efforts by manufacturers to address how public safety authorities should approach ADS-equipped vehicles. For example, as part of the vehicle registration requirements associated with California's application for the Autonomous Vehicle Tester Program – Testing with a Driver, manufacturers are required to provide a statement of facts that includes a brief description of the autonomous technology or features integrated into the vehicle and the functional capabilities made possible by this technology (California Department of Motor Vehicles, 2018a). As of August 29, 2018, 60 entities (including Ford, GM Cruise LLC, Honda, Mercedes Benz, Nissan, and the Toyota Research Institute) have been issued Autonomous Vehicle Testing Permits (with a driver) (California Department of Motor Vehicles, 2018b) . Waymo's application (Waymo, 2018a) includes a section titled "Waymo Law Enforcement Interaction Protocol." In this protocol, Waymo provides a toll-free telephone number for police, firefighters, and other first responders to call to obtain owner information, vehicle registration, and proof of insurance. Waymo has specified locations for these documents in the vehicle and offers to provide that information directly over the telephone to any authorities who call. The

documents include instructions for safely removing a Waymo vehicle from the roadway and how to recognize when the vehicle is in "self-driving" mode.

Some companies have prepared supplemental guides for emergency responders, for instance, Waymo's Emergency Response Supplement guide (available for the 2017 Chrysler Pacifica Hybrid), which is available online in PDF format (Waymo, 2018b). The document includes methods for identifying a Waymo "fully self-driving" vehicle (i.e., an ADS-equipped vehicle in DO) by its external features, how to approach the vehicle, what to look for to ensure the vehicle is immobilized, how to disable the vehicle and turn off the engine, methods for towing, ways to access the vehicle's interior compartments, and electrical information. The document also provides a toll-free number for first responders to call for more information (Waymo, 2018b).

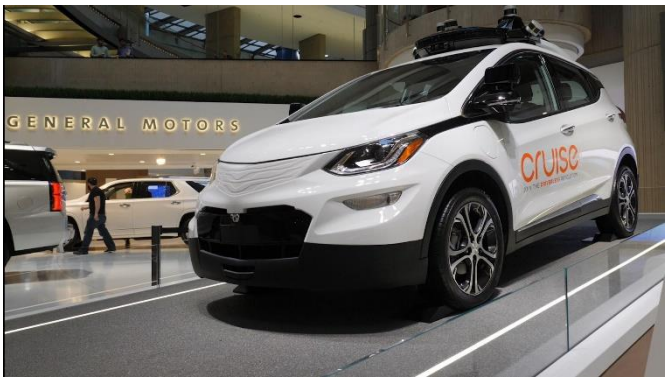



**Figure 1. GM's Cruise AV.**

General Motors has expressed their intention to continue outreach and training efforts as ADS-equipped vehicles are deployed, educating first responders on how these vehicles conform to local law requirements (e.g., where to find registration and insurance) and what to expect when interacting with the vehicles (General Motors, 2018). For example, General Motors has worked with the National Fire Protection Agency (NFPA), the International Association of Fire Fighters, the International Association of Fire Chiefs, the Association of Public Safety Communications Officials, fire and police chiefs, and 911 call centers to provide training on electric vehicles. General Motors has also indicated that their ADS-equipped vehicles will have two-way communications that allow first responders to interact with remote advisors, if needed (General Motors, 2018; See Figure 1 for an example of GM's Cruise AV).

When considering hybrid vehicles, steps have been taken to inform public safety authorities of recommended procedures, components, and cut zones. For example, SAE J2990_201211 Hybrid and EV First and Second Responder Recommended Practice describes "the potential

consequences associated with hazards from xEVs,[1] and suggest[s] common procedures to help protect emergency responders, tow and/or recovery, storage, repair, and salvage personnel after an incident has occurred with an electrified vehicle." The standard notes that, "Industry design standards and tools were studied and where appropriate, suggested for responsible organizations to implement" (SAE International, 2012).

Public safety associations have also worked to educate their members on the potential hazards associated with hybrid vehicles. For example, the NFPA (National Fire Protection Association, 2018) has worked with 30 alternative fuel vehicle manufacturers to provide guidance to fire personnel and other first responders. Individual manufacturers have extended this feedback to their full lines of gasoline-electric hybrids in both the United States (Honda North America, 2018b) and Canada (Honda North America, 2018a).

## 1.4 Document Overview

The objectives of this research effort were to:

- Determine common public safety scenarios through a literature review and subject matter expert opinions
- Use a Hierarchical Task Analysis (HTA) to analyze and breakdown the tasks of each scenario step-by-step
- Verify that the safety scenarios are complete by requesting further subject matter expert opinion via focus groups and interviews
- Inquire how introduction of ADS-equipped vehicles in DO may change current procedures conducted in each scenario
- Determine opportunities where the interactions of public safety officials could be improved with the introduction of ADS-equipped vehicles in DO

The steps taken to accomplish these objectives will be the focus of this document:

- Chapter 2 describes the research methods associated with the project tasks, including the literature review, HTA, and DO needs assessment.

[1] "Any electrified propulsion vehicle with a high voltage system, including but not limited to HEV, PHEV, PEV, BEV, FCEV, and EV" (SAE International, 2012).

- Chapter 3 provides additional details on the DO needs assessment data analysis efforts.
- Chapter 4 presents the literature review and HTA.
- Chapter 5 discusses of the DO needs assessment findings for each operational scenario.
- Chapter 6 summarizes to key findings from the DO needs assessment.
- Chapter 7 draws attention to potential opportunities for improved operational procedures and interactions moving forward.

# Chapter 2: Research Methods

## 2.1 Theoretical Framework

This research effort explored the types of interactions each public safety domain has with a broad spectrum of non-emergency public and private vehicles. This was done by first determining the most common types of interactions and then performing an HTA on those interactions by mapping the procedures in detail and then verifying these procedures through a DO needs analysis. The method for mapping the procedures is primarily a step-by-step breakdown of how the tasks are ordered and conducted. By applying socio-technical-systems (STS) theory, contingencies within the procedure were developed. STS theory presents a framework made up of four subsystems: 1) technology, 2) people, 3) organizational design, and 4) environment (Hendrick & Kleiner, 2001). For example, the procedures for traffic control can change depending on the environment. At night or in low-light conditions, traffic controllers utilize flashlights or traffic wands to communicate with traffic, while during the day they typically use only their hands (Figure 2). Regarding technology, the method for obtaining a license plate number can differ depending upon whether or not a specific police agency utilizes automatic license plate reader technology.


**Figure 2. Examples of daytime and nighttime traffic direction.**

## 2.2 Research Approach

The goal of this research was to determine opportunities where the interactions that public safety officials have with other vehicles could be improved with regard to the introduction of ADS-

equipped vehicles in DO. To identify these opportunities, a mixed-method approach was adopted that included a literature review, HTA, and driverless operation needs assessment (Figure 3):

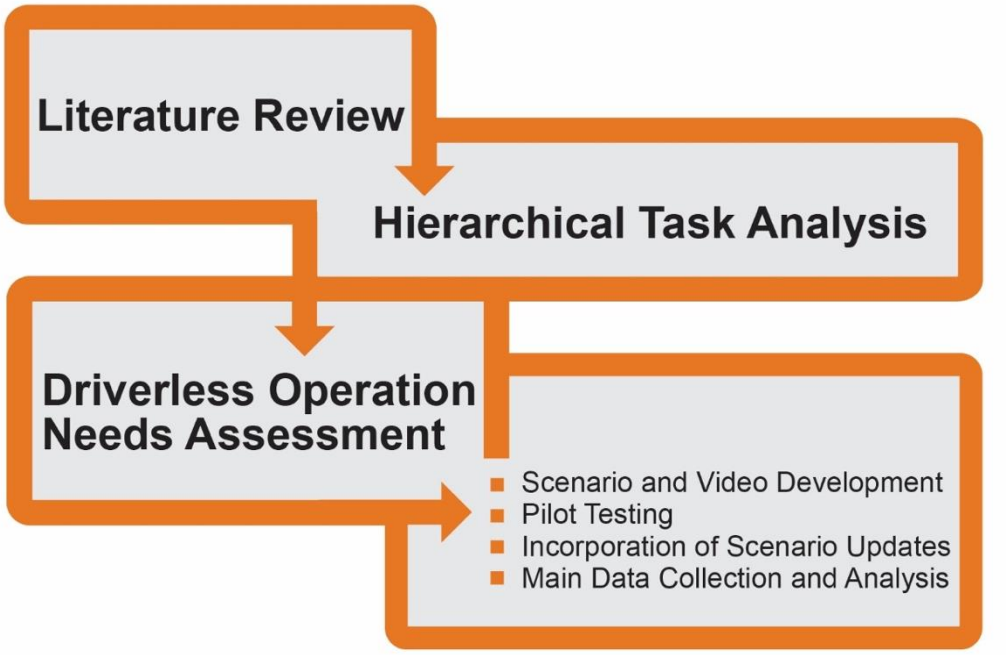



**Figure 3. Mixed methods task outline.**

1. **Conduct a literature review**: Through an extensive review of operational manuals and conversations with subject matter experts (SMEs), key aspects of public safety officials' tasks and the most common operational scenarios where public safety officials interact with non-emergency vehicles were identified. Six operational scenarios were selected for further analysis. Of the six, three are shared by law enforcement, fire and rescue, and EMS, two are specific to law enforcement, and one was specific to fire and rescue (Figure 4).


**Figure 4. Six operational scenarios identified through the literature review.**

2. **Perform an HTA:** The step-by-step tasks associated with these operations were mapped using the HTA method. The HTAs illustrated the general approach that public safety officials would take to complete an operation based on the researcher's understanding of the available literature and the guidance provided by SMEs. The HTAs highlighted different types of interactions as well as any important task that was common to the operation. Additionally, the written component to the literature review provided greater detail as to when a particular operation or task in the HTA was discretionary or depended upon a specific circumstance.
3. **DO Needs Assessment**: Using the outcomes of the literature review and the HTA as a starting point, a project overview, technology introduction, and 12 scenario- and domain-specific videos were created and vetted through SME review. Based on the SME review, the scenario descriptions and videos were updated. Data were then collected through a series of focus groups and one-on-one interviews with law enforcement, fire and rescue, and EMS personnel. Results of the focus group and interview effort were used as follows:
    a. Revisions to the HTAs: Operational components that were specified by the SMEs were used to reshape or supplement the initial HTAs. This is an effort to make the outline of the operations more complete and universal to North American public safety officials and their operations. These operations are detailed in Chapter 4: Interactions between Public Safety Authorities and Vehicles.
    b. Identification of Interactions: Points in each scenario where ADS-equipped vehicles in DO could improve the interactions that public safety officials have with vehicles were identified. In addition, specific needs personnel have within each scenario were further explored.

Additional information about each of these efforts is discussed in the following sections.

## 2.3 Literature Review and HTA

Task analyses are often used to break down operational system tasks in an effort to identify opportunities to increase efficiency between humans and machines or humans and a system or set of subsystems (Annett, 2003). In many cases, an HTA is employed after a problem has already been identified with an interaction, such as a worker being unable to complete a set of tasks within a set amount of time or a user being unable to navigate a mobile app effectively. In

other cases, an HTA is conducted simply to identify the subtasks of an operation for training or documentation. The efforts of this literature review and HTA will fall into the latter category, as the tasks and subtasks associated with the interactions that public safety authorities have with ADS-equipped vehicles will be explored and described. It is worth noting that while this literature review will refer to the identification and description of tasks performed as a *task analysis*, it is more accurately a *task description* (R. B. Miller, 1962). The difference between the two are that an analysis serves to provide solutions to identified problems whereas a description outlines the tasks and subtasks and is not focused on any type of solution. The information presented here is intended to provide a strong foundation for a potential future research to complete a task analysis by seeking opportunities within task descriptions to benefit the interactions.

HTA is a goal-based analysis of a system where the goals for each subtask describe the system as a whole (Shepherd, 1985; Stanton, 2006). The HTA process is a decomposition of overall tasks into subtasks at any preferred level of detail (Annett, 2003). A relevant, yet simple, example that illustrates HTA would be a police officer who must determine whether an ADS-equipped vehicle in DO has an occupant inside (Figure 5). In this example, the overall goal of the officer is to ensure the vehicle is clear of occupants. It may be assumed, due to the positioning of the vehicle on the roadway, that it would be unsafe for an occupant to remain in the vehicle and, therefore, removing any occupants inside the vehicle is considered the goal. A process to carry out goal "0" (as is the common HTA nomenclature for the ultimate goal) is shown as "Clear vehicle of occupants" in Figure 5. Here, the police officer must inspect the vehicle to determine if it is clear, presumably by looking inside. If the vehicle is clear, the task is ended and no further subtasks for clearing the vehicle need to be executed. If the vehicle is not clear, the officer must move to subtask 2. It is here that the task analysis will increase in complexity as the dotted line indicates a route to another, and perhaps more complex, set of subtasks. The subsequent operations may require the officer to check the door handles of the vehicle to see if they will open and then actively remove an occupant who may be incapacitated. When no more occupants remain, the task is complete.

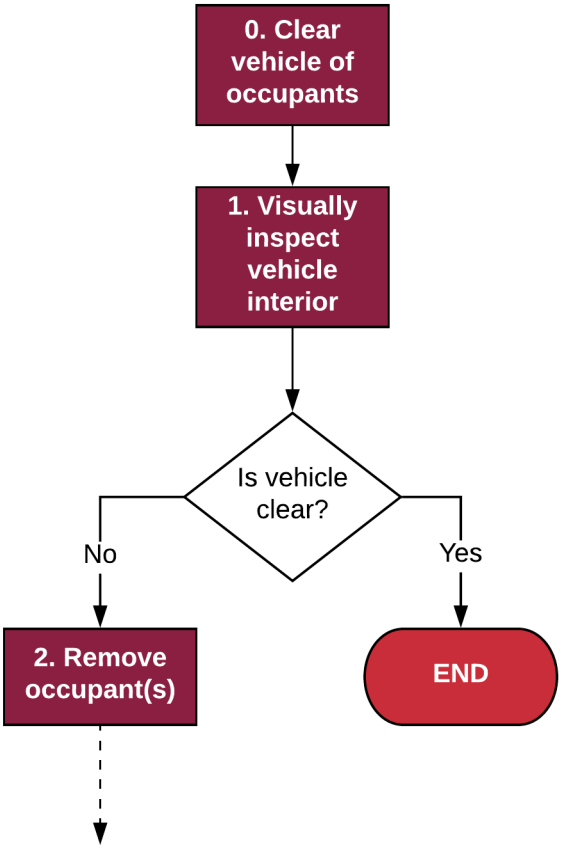



**Figure 5. Example hierarchical task analysis.**

While this example is rudimentary and provides an overly detailed breakdown of how to determine if a vehicle is cleared, it is relevant, as advances in ADS technology may affect how easily a vehicle can be inspected or accessed internally by an officer. The focus of the HTA is not to postulate on what technological advancements—real or imagined—may interfere with the current vehicle interaction protocols of public safety organizations but instead to procedurally map the protocols currently in place.

### 2.3.1 HTA Components and Definitions

As noted, an HTA begins by identifying the goals of a task (Annett, 2003). One law enforcement task, for example, is an officer indicating to a vehicle violating the speed limit that it should pull over. The next step of a task analysis is the process of decomposition, whereby subtasks and their goals are identified (Annett, 2003). In this example, the officer would likely begin following the vehicle in violation and activate the police vehicle's emergency lights. The goal of this task is to

alert the driver of the speeding vehicle to the officer's presence and communicate to that driver the request to stop. Here, the task may fragment: Does the driver respond and slow down? Do they do nothing? Does their speed increase? The discretion of the officer will come into play, with each path generating new subtasks and subgoals.

There are three key aspects to an operation in a task analysis: input, action, and feedback (Annett, 2003; G. Miller, Galanter, & Pribram, 1960; Shepherd, 1985). To achieve any goal will require some input to activate the task, followed by actions to complete the task, and then feedback to determine if the goal has been accomplished. These three components form the loop of an operation where the feedback will determine the next input and, thereby, the next action to produce more feedback until the loop is exited.

Rules or processes associated with an operation are referred to as plans (Annett, 2003; Shepherd, 1985). Plans can be made up of fixed-sequence procedures that follow an A→B→C→D path or decision-based procedures where the path may be represented as: if A→X; if B→Y. A dual task is a third type of plan, where a goal cannot be attained unless two or more other goals are met simultaneously (Annett, 2003).

An important aspect of an HTA, and specifically relevant to this research effort, is when to stop decomposing a task, as many operations and sub-operations can be broken down almost infinitely. A stop rule determines when the process ends and should be defined prior to attempting a task analysis (Annett, 2003). For the sake of this research, the efforts of the HTA will focus on specific interactions between public safety authorities and other vehicles. When there are no longer any interactions left in a task, the analysis will end, regardless of the goal. For example, if the goal of a first responder is to remove a passenger from a damaged vehicle, once the responder has accessed the interior of the vehicle and removed the passenger the analysis will end. Similarly, a task where law enforcement requests that a driver step out of their vehicle would end once the driver is outside of the vehicle and law enforcement requires no further interactions with that vehicle.

### 2.3.2 HTA Notation

Notation is key to creating an HTA diagram that can be easily followed and understood. There are several different methods used to notate an HTA, and while there is no declared correct or incorrect method, there are some agreed-upon best practices. For example, a numbering system

is recommended to identify tasks and subtasks. A task labeled 1 would have subtasks 1.1 and 1.2; subsequent subtasks would be 1.1.1 and 1.2.1, respectively, and so on. In an HTA diagram, a solid horizontal line beneath a box indicates a stop (Annett, 2003). The shapes used in an HTA flow diagram and their associated meanings are guided by ISO 5807:1985 (International Organization for Standardization, 1985). A diamond typically represents a contingency where an operator determines whether a goal or subgoal has been completed, and rectangles or squares represent processes (Figure 6). Other shapes used in the HTAs in this document include a notation for "End" (see Figure 5 for an example) and for "Dispatch," which indicates a two-way informational exchange.

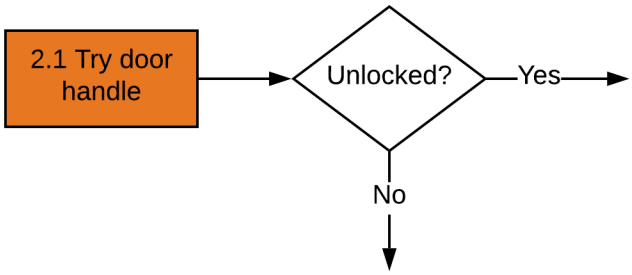



**Figure 6. HTA shape application example.**

Each task is broken down into the different types of interactions: direct, indirect, and informational. An interaction is considered *direct* when there is physical contact between a public safety authority and a vehicle, such as checking the door handles to access a vehicle, knocking on a window to alert a driver, or opening the hood of a stranded motorist's vehicle to provide mechanical assistance. *Indirect* interactions are those where a public safety authority must communicate information to other drivers, and might include events such as a fire truck engaging its lights and sirens en route to a call or police activating their lights behind a vehicle they wish to pull over. Lastly, *informational* interactions are those where information, such as license plate, registration, licensure, or proof of insurance, must be obtained from the occupant or vehicle. These interactions may be done remotely through technology, such as with a license plate reader, or via documentation handed over by a vehicle's driver or occupant. The HTA conducted as part of this literature review uses different colors to identify the three interaction types: direct, indirect, and informational (see Figure 7).

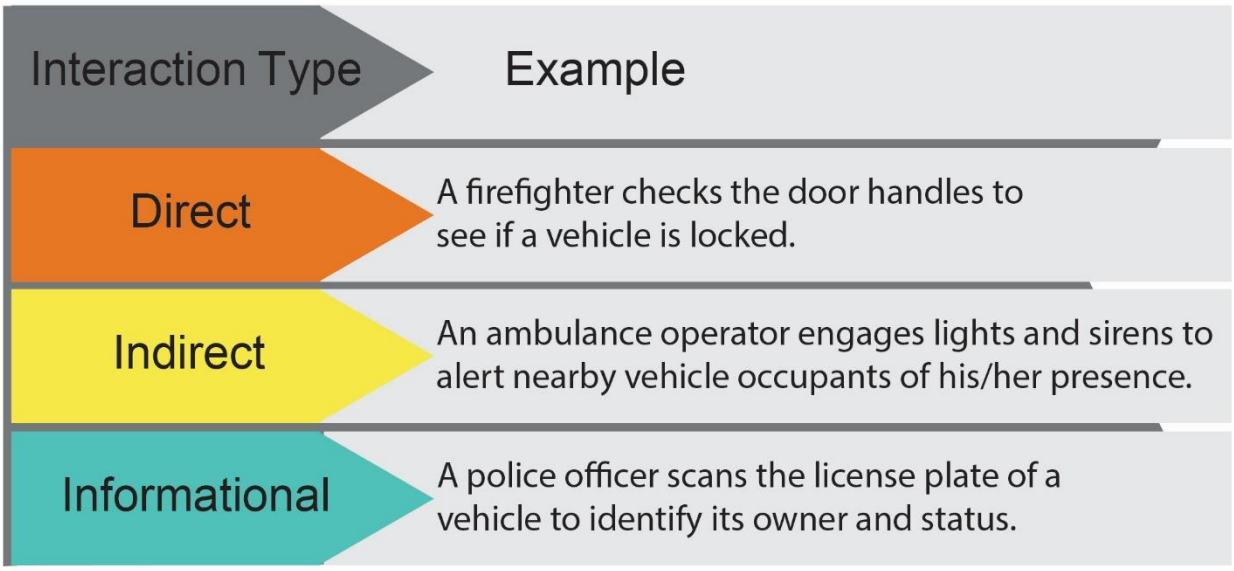



**Figure 7. Interaction types and examples.**

## 2.4 Driverless Operation Needs Assessment

In developing the driverless operation need assessment, the benefits of quantitative and qualitative research methods were considered. Quantitative research, such as surveys, ask a consistent set of questions to a group of participants and can yield a conclusive set of results. Conversely, qualitative research efforts, such as focus groups and one-on-one interviews, provide greater opportunities for exploratory research while still asking a consistent set of questions. These facilitated discussions provide environments conducive to sharing honest opinions. As a result, researchers can better understand not only what participants think, but also how and why they think the way they do.

For this effort, it was important that participants perceived the focus groups and interviews as being safe and non-judgmental spaces for the sharing of information. Consequently, researchers were able more completely understand the nuances in operational procedures associated with the six scenarios. Further, the researchers were able to gain insight into opportunities associated with the introduction of ADS-equipped vehicles in DO.

When considering the results of this effort, it is important to recognize that while participants were asked a consistent set of open-ended questions, participants focused their answers on aspects of the operations that were most significant to them at the time. It is important to note that these counts represent the number of responses and not the number of participants. It may be likely that

an idea expressed in one focus group also may be considered important by those in a second focus group; however, due to the focus of the conversation within the second focus group, the idea was not expressly discussed. Further, the same participant(s) may have expressed the same idea in response to multiple questions.

### 2.4.1 Scenario and Video Development

Operations conducted by public safety officials involved in law enforcement, fire and rescue, and EMS were converted into scenarios for the purposes of the data collection effort. Through a review of the available literature and discussions with SMEs, it was determined that the following operations were most common and involved the most routine interactions between public safety officials and the vehicles they routinely interacted with (Figure 8).

Each of the operations in Figure 8 were converted into step-by-step procedures from the point of view of the public safety officials. The procedures were illustrated using an HTA that mapped the procedures in order, highlighted the different interaction types (direct, indirect, and informational), and provided contingencies for decision points.

| Scenario | Law Enforcement | Fire and Rescue | EMS |
|---|---|---|---|
| 1. Respond to an incident | ● | ● | ● |
| 2. Secure a scene | ● | ● | ● |
| 3. Traffic direction and control | ● | ● | ● |
| 4. Traffic stops and checkpoints | ● | | |
| 5. Abandoned or unattended vehicle | ● | | |
| 6. Stabilization and extrication | | ● | |

**Figure 8. Key public safety operations and associated domains.**

In total, nine HTAs were developed and included the six key public safety operations specified in Figure 8. Traffic stops, checkpoints, stabilization, and extrication were developed as separate HTAs and combined for the video scenarios. An HTA was also developed for a motorist assist operation; however, this was not ultimately chosen as one of the key scenarios.

Once the HTA procedures were refined and checked against the literature and the opinions of SMEs, the procedures were then converted into scripts that were narrated over videos where pictures showing the actions detailed in the script were presented along with bulleted information that supplemented the narration. The purpose of the videos was to ensure that the concepts of the

scenarios presented to the participants were clear and consistent for each focus group and interview conducted by the research team.

In addition to the videos detailing the different operational scenarios, the research team created two other videos: 1) an introduction video to show at the beginning of the interview, and 2) an introduction to automation video that detailed the concepts of an ADS-equipped vehicle in DO. The introduction video explained the purpose of the research, emphasized that the focus is on the interactions that public safety officials have with other vehicles, and detailed the different types of interactions. The video describing automation explained how a vehicle in DO may be operated and that there may or may not be occupants inside the vehicle at times. To ensure terms could be understood by participants in a short amount of time, some terms were simplified from the SAE J3016_201806 suggested language (e.g., vehicles equipped with automation in driverless mode as opposed to an ADS-equipped vehicle in DO, which would have required an explanation of the levels of automation, of ADS, and of variations in DO).

Figure 9 presents a screenshot from the Fire and Rescue: Traffic Direction and Control video. This screenshot is reflective of the formatting across the videos. The video durations ranged from 1 minute, 38 seconds for the project introduction to 5 minutes, 2 seconds for Law Enforcement: Traffic Stops and Checkpoints.

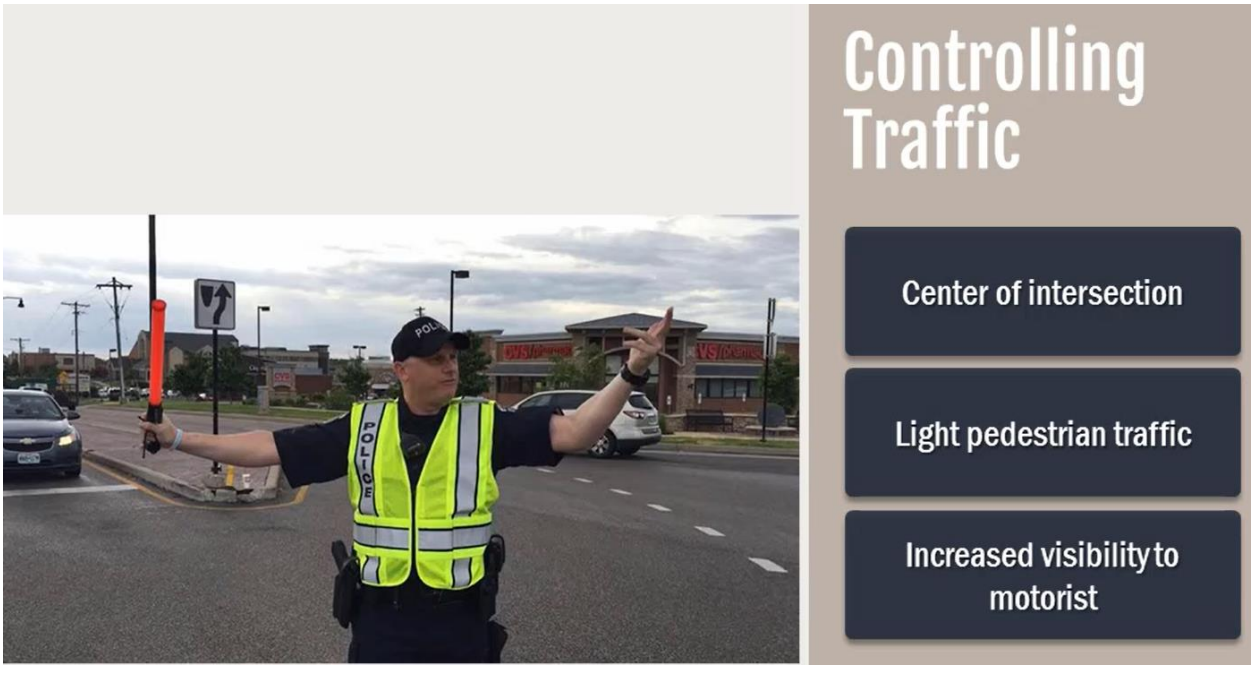



**Figure 9. Screenshot of narrated video for Fire and Rescue: Traffic Direction and Control.**

### 2.4.2 Pilot Testing and Incorporation of Scenario Updates

Pilot testing consisted of nine interviews and two focus groups across the collaborating institutions of the Virginia Tech Transportation Institute (VTTI) and UMassSafe. Participants were a mix of active duty public safety personnel and trainers of public safety operations. The use of pilot interviews allowed the teams to obtain feedback from SMEs on the types of questions and materials used in the interviews and the completeness and accuracy of the scenarios.

The feedback provided during the pilot test was incorporated into the study methods for the main data collection and analysis to come. For example, scripts were adjusted in favor of more concise wording and modified phrasing, and video images were altered to more completely reflect procedures. Operation-specific feedback was added to HTAs, incorporated into the literature review, and reflected in the scenario videos for the main data collection phase.

### 2.4.3 Main Data Collection and Analysis

Two types of interviews were conducted: 1) focus groups with active duty personnel within law enforcement, fire and rescue, and EMS, and 2) individual interviews with senior or higher-level personnel within those same public safety departments.

Focus groups were chosen as part of the data collection research methods because they allow for multiple subjects to participate at one time and for natural discussion to generate new ideas. The focus groups consisted of active duty personnel balanced across the different jurisdictions and department types.

Interviews with single participants were incorporated to garner insight and opinions from higher level personnel. It was believed that because there are fewer administrators, such as police and fire chiefs or EMS supervisors, a large number of focus groups consisting of these participant types would be difficult to recruit and schedule. It was also believed that the higher-level personnel would potentially be more active in participating in a discussion due to the responsibilities of their positions and previous experiences.

For this research, higher level personnel were defined as a supervisor of active duty personnel; by way of example, a police chief or captain of a police department, or a fire chief of a fire hall

or fire department. These personnel are expected to have more experience in both active duty operations as well as education in how active duty personnel are trained.

Focus groups and interviews were conducted online via Zoom Video Communications web conferencing software. Video capabilities were used only to share project overview and scenario videos; no video recordings of participants or facilitators were made. Audio was recorded using the Zoom Video Communications software and a handheld digital recorder. Participants were only recorded after declaring their verbal consent to the Informed Consent document to participate in the research and be recorded (see Appendix A). The Zoom Video Communications software is free to download, and each eligible participant was informed how to install, initiate, and navigate the software.

The research team conducted a total of 20 focus groups and 28 individual interviews. Each focus group and individual interview was segmented by specific jurisdiction types, as explained below.

#### *2.4.3.1 Jurisdictions, Department Types, and Populations*

The focus groups and interviews were divided by public safety domain: law enforcement, fire and rescue, and EMS. Within each of those domains were different jurisdiction and department types.

Law enforcement consisted of three jurisdiction types: state, county, and city. State police, referred to as highway patrol in some states, are police who maintain law and order across a state jurisdiction; this includes patrolling roadways and enforcing state laws. County police have jurisdiction within a particular county within a state and have many of the same duties as state police but often on more rural roadways. County police are usually a part of a Sheriff's office and do not operate within any specific city or town. It was determined via this research that in some areas of the United States—the New England area specifically—Sheriff's offices do not perform the same duties as in the rest of the country. The county Sheriffs and deputies of the New England area often serve as jailers and bailiffs, for example, and do not conduct many of the same operations as general law enforcement. For the purpose of this study, the term "city police" is used to describe any police from a specific municipality, city, or town, to differentiate from county and state. City police operate within the limits of a town or city and, within one city or town. There is often overlap in jurisdiction between state, county, and city police when it

comes to responding to certain incidents such as major crashes. The specifics of authority within the overlapping jurisdictions are often negotiated on an area-to-area basis.

Within each jurisdiction is a grouping of location-specific populations. This grouping was not applied to state police as recruitment of state police participants sought simply to recruit state policemen trained to operate anywhere within that state. For the jurisdiction of county and city police, a distinction was made between rural or sparsely populated areas and urban or densely populated areas. The reason for this distinction was to differentiate between the relative volume of calls and the potential for more resources within a specific department.

Counties were divided by population as either being rural or populous, as the term “urban” would not strictly apply. The U.S. Government Census Bureau does not define rural or urban thresholds for counties as it does for cities and towns. For the purpose of this research, a county was considered rural if the population density was less than 100 people per square mile and was considered populous with a density of 100 or more people per square mile. The population figures can be gathered by the Census Bureau website and search tool at www.census.gov.

The Census Bureau does define rural and urban cities by population. For the 2000 census, a rural city or town consisted of less than 1,000 people per square mile, and an urban city was defined as 1,000 or more people per square mile ("Census 2000 Urban and Rural Classification," 2015). The determination of urban and rural shifted in 2010 when the Census Bureau began using cluster metrics and incorporating metropolitan zones for determining rural and urban classification as opposed to single population numbers from a particular location. The 2000 method was chosen to be used for this project as it provides a clear indication of rural versus urban that could be leveraged by the recruitment team when seeking potential participants. This method is still recognized as valid but no longer preferred for census purposes.

#### *2.4.3.2 Recruitment*

Participants were recruited using scripts for contact by telephone and email found in Appendix A or Appendix B, which was approved by the Virginia Tech Institutional Review Board (IRB).

The criterion for focus group participant eligibility was only whether they were active duty personnel. There were no age, experience, or gender restrictions for participation. The research team sought to incorporate 24 states, and, within those states, the jurisdictions and populations

were recruited for and balanced. Participants could be excluded if a particular jurisdiction was already filled from the same state. There was one exception of a paid/combined EMS and Fire and Rescue focus group participant who insisted their colleagues be present for the interview. All four of the participants were from the same department and consented to participate. Although these participants completed the study, their responses were not recorded in the data analysis or recruitment counts as they did not meet jurisdictional conditions (cannot participate within the same focus group if they are of the same department).

Once a participant was screened for eligibility using the appropriate screening form, they were sent a confirmation email with several attached documents (Appendix A or Appendix B). These documents included an Informed Consent Form, a list of discussion reference guide questions to prime them for discussion, instructions to connect via Zoom, and the date and time of their confirmed appointment.

To solicit a wide variety of responses from jurisdictions across the United States, participants from 24 states were contacted with a completed total representation of 22 participating states. Geographically, states were divided among the two research institutions based on existing contacts and geographical proximity within the United States. Figure 10 displays the dispersal of participation by state colored in yellow.

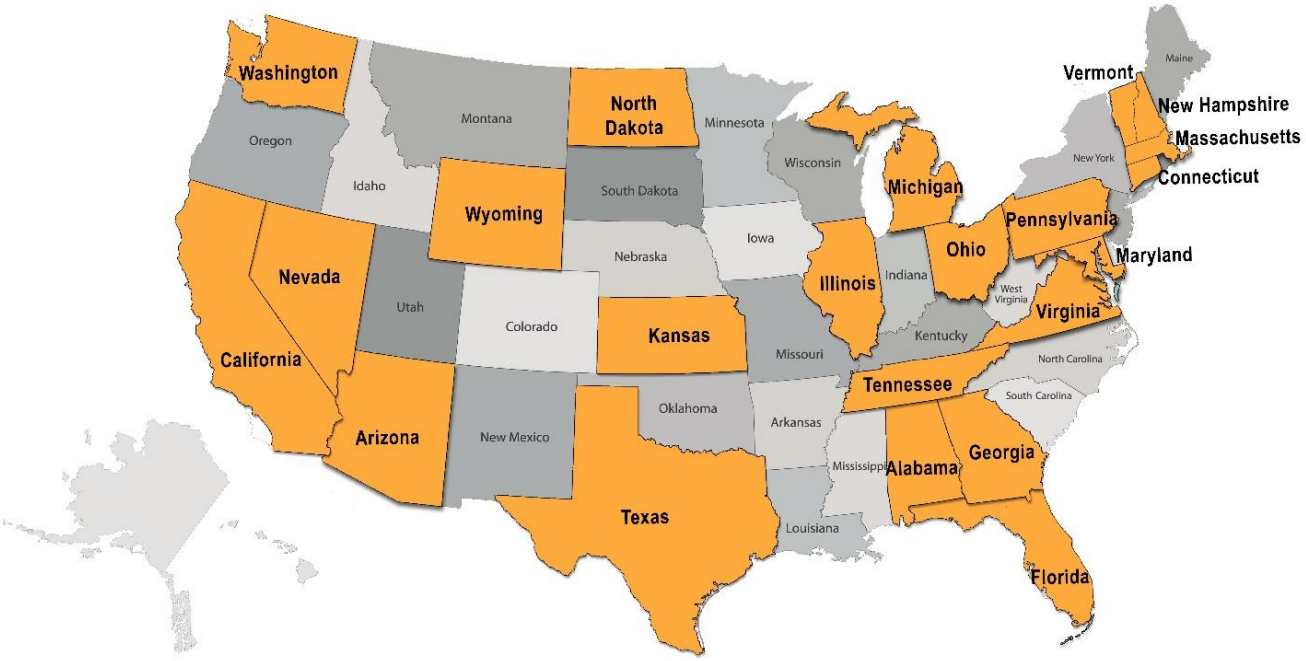



**Figure 10. United States law enforcement participation by state.**

Canadian provinces were identified and contacted based on geographical proximity to the U.S. border. While recruitment efforts targeted each province, participants ultimately represented law enforcement perspectives from Alberta, Ontario, and New Brunswick (Figure 11).

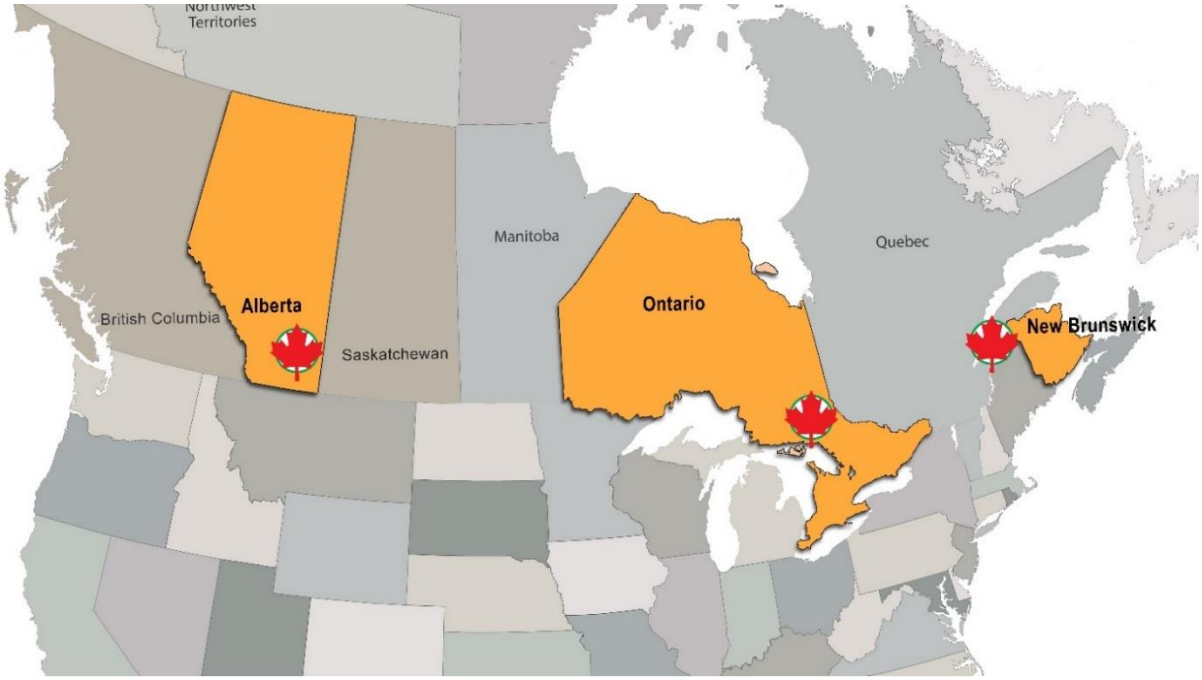



**Figure 11. Canadian law enforcement participation by province.**

#### 2.4.3.2.1 Law Enforcement Recruitment

Within the U.S., state police contact information was primarily identified by searching for the respective state police, department of public safety, or the highway patrol headquarters' public website. Counties and cities identified within states were divided into categories of populous/urban or rural according to the method described in 2.4.3.1 Jurisdictions, Department Types, and Populations of this report. Once the correct population delineations were identified, an online search for public websites was conducted for city police departments and county Sheriff's offices.

Canadian recruitment efforts were conducted similarly to the U.S. recruitment. The team used public departmental websites for firefighters, EMS officers, and law enforcement as the primary method of obtaining contact information. Canada's federal and national police force is referred to as the Royal Canadian Mounted Police (RCMP), which is divided into provincial headquarters, and then smaller detachments. These detachments were not divided into rural/urban delineations like the United States due to the geographical sprawl of population density within each province.

The first point of contact for all jurisdictions by telephone was through the main public phone line. The primary concern of the law enforcement jurisdiction was connecting to the most relevant department. As each department varied in structure, to connect with the most relevant department, prerecorded menu options were used, when possible, to direct the recruiter to the most appropriate option. The most frequently selected options for recruiting efforts were either the traffic division, the public safety office, or the direct line to the administrative office of a chief or deputy chief. Many administrative personnel were reluctant to connect the recruiter directly to those in leadership positions. Alternatively, they offered to transfer the recruiter to a lieutenant or sergeant, for example, or to pass along a forwarded email. The first point of contact via email was directed at any public information provided on a department's website, such as a sergeant or chief's name and email address. The states representative of participation for populous and rural counties can be found in Figure 12. The states representative of city law enforcement participation, both rural and urban, can be located in Figure 13.

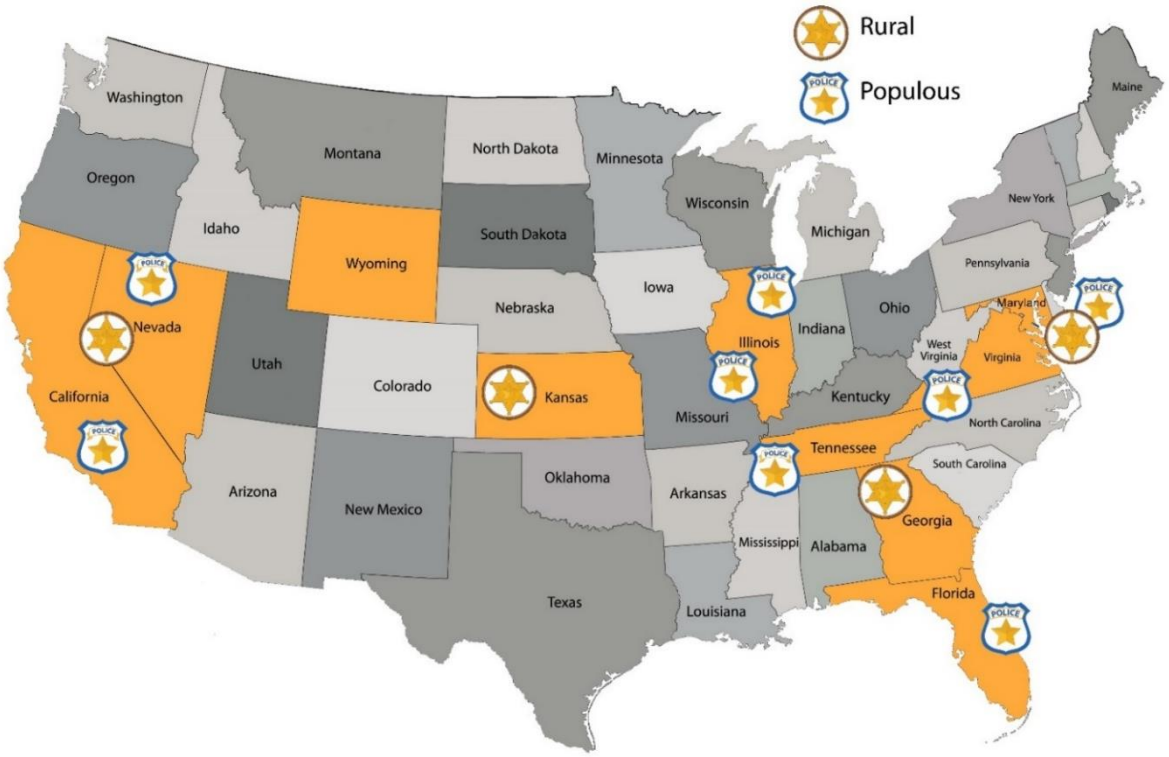



**Figure 12. County law enforcement participation by state.**

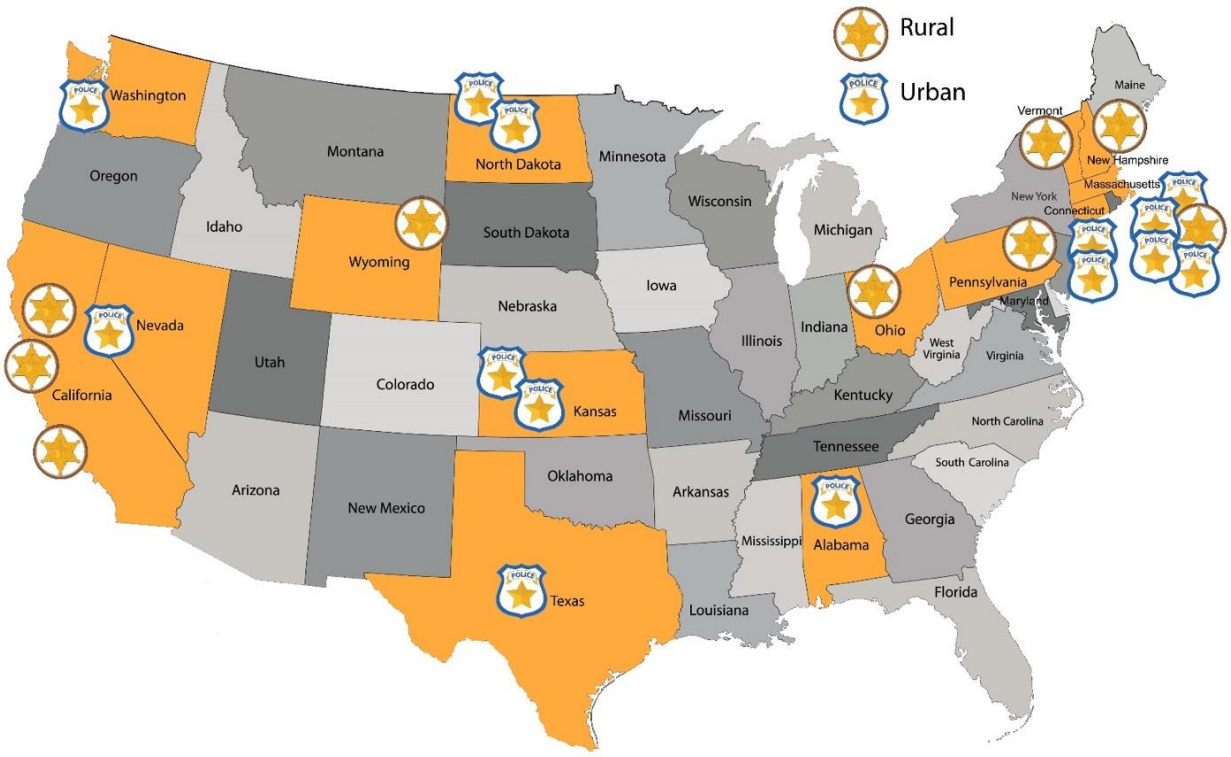



**Figure 13. City law enforcement participation by state.**

### 2.4.3.2.2 Fire and Rescue Recruitment

When calling the main public phone lines of both paid and volunteer fire departments, recruitment experienced a higher response rate from paid fire departments. This is likely due to a higher number of paid staff during business hours. Volunteer departments resulted in more referrals to voicemails as they did not always have staff on call to take a message. Occasionally, the main phone line was the personal cell phone of the fire chief. The 9 participants who completed the study from both volunteer and paid fire departments are presented geographically in Figure 14. While there was interest from Canadian fire departments, none were available to participate in this study.


**Figure 14. Volunteer fire and paid fire and rescue participation by state.**

### 2.4.3.2.3 EMS Recruitment

Despite varying department sizes, the EMS jurisdictions main public phone line went directly to personnel instead of to prerecorded phone menu options. Unique to EMS, their department heads were referred to as managers and not chiefs, the title relevant to the fire and law enforcement jurisdictions. When contacting the main phone line, personnel either transferred the recruiting team directly to their manager's voicemail or provided their personal email. The eight participants who completed the study from both volunteer and paid EMS departments are shown geographically in Figure 15. The recruitment team was unable to recruit any Canadian EMS personnel.

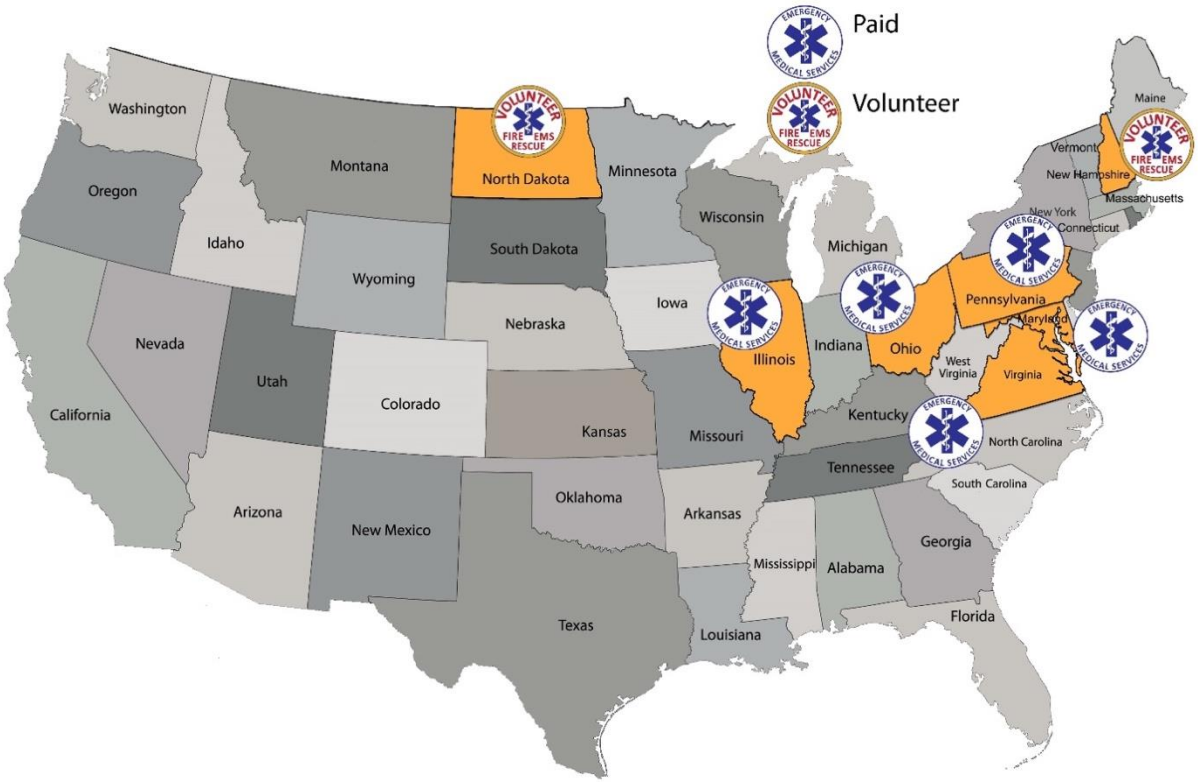



**Figure 15. EMS participation by state.**

### 2.4.3.2.4 Recruitment Summary

Through telephone and email, there were a total of 961 jurisdictions contacted between the U.S. and Canada. The 2,671 total attempts, shown in Table 2, represent follow-ups conducted by telephone or email, using the IRB rule of no more than three contacts per participant. Out of these 2,671 total attempts, a total of 163 were screened. Out of those 163 screened, 79 completed participation in this study.

**Table 2. Recruitment Results**

| Category | Number of Jurisdictions | Total Attempts | Screened | Completed Study |
|---|---|---|---|---|
| State Police | 23 | 262 | 39 | 20 |
| County Police | 271 | 706 | 14 | 13 |
| City Police | 451 | 969 | 57 | 23 |
| Fire | 96 | 311 | 21 | 9 |
| EMS | 45 | 329 | 24 | 11 |
| Canadian Police | 42 | 58 | 4 | 3 |
| Canadian Fire | 23 | 26 | 1 | 0 |
| Canadian EMS | 10 | 10 | 3 | 0 |
| **Totals** | **961** | **2671** | **163** | **79** |

#### 2.4.3.2.5 Recruiting Challenges and Barriers

A challenge the recruitment team faced was navigation past the initial contact on the main phone line. Various departments preferred to redirect the call to either media relations or the police training academy. The recruiting team overcame this by emphasizing the desire for an officer that is currently in the field or their superior who would be willing to nominate an officer for participation.

Response times varied depending on the leadership structure of departments. Law enforcement officers often required approval to participate from either an officer's supervisor or the department head. The explanation of the discussion topics in the recruiting script were made vague to protect the proprietary nature of the study. As a result, many officers declined participation as they had previously been involved in interviews about "protocols," which then led into police violence discussions. The recruitment team attempted to overcome this by emphasizing the transportation-related nature of the discussion and the various transportation-related scenes involved.

Canada posed the unique problem of language barrier and international relations. Recruiting efforts were halted in some provinces, such as Québec, when they were unable to locate an English speaker within their detachment. Others were weary of sharing their protocols due to concerns of political motivations of Americans contacting law enforcement officials. Recruitment attempted to overcome these concerns by emphasizing that this study was sponsored by a consortium of automakers and not by a political organization.

# Chapter 3: DO Needs Assessment Data Analysis

This section details the methods used to identify the themes and opportunities associated with the DO needs assessment. Qualitative data analysis followed a four-step process that draws upon Marshall & Rossman (1999) and a modified version of framework methodology (Ritchie, Spencer, & O'Conner, 2003). This approach has been used successfully in several past VTTI research efforts (e.g., Blanco et al., 2015) and allows researchers to manage and analyze the data in a logical and complete manner. Using this iterative approach allows the researchers to transform the data from recorded audio, to written transcript, to charts and data in a manner that is comprehensive, transparent, and traceable.

## 3.1 Data Organization

The researchers reviewed and became familiar with the dataset. This included cleaning the data (e.g., minor editing necessary to make materials retrievable) and preparing the data for analysis. To prepare the data for analysis, it was first transcribed using established protocols designed to ensure consistency across all transcripts.

## 3.2 Generation of Themes and Subthemes

Next, researchers reviewed the transcripts to become familiar with key themes and subthemes. The initial themes and subthemes closely followed the scenarios, key questions, and follow-on question areas within each focus group and interview. Themes and subthemes were then arranged in a logical order with individual spreadsheets, with the spreadsheet tabs serving as an index.

## 3.3 Data Coding

Responses were coded by theme and subtheme and grouped according to emerging patterns or categories. The indexed comments were arranged into scenario-specific Microsoft Excel® workbooks, and individual spreadsheets (or thematic charts). These spreadsheets/thematic charts were then further sorted by subtheme (i.e., question or follow-up question) and secondary subthemes. The secondary subthemes were the type of potential vehicle interaction: direct, indirect, and informational. Finally, categories of similar ideas were created based on the subthemes. Once sorted, the secondary subthemes and categorical responses were tallied and are reported in the subsequent chapters using descriptive statistics (Figure 16).

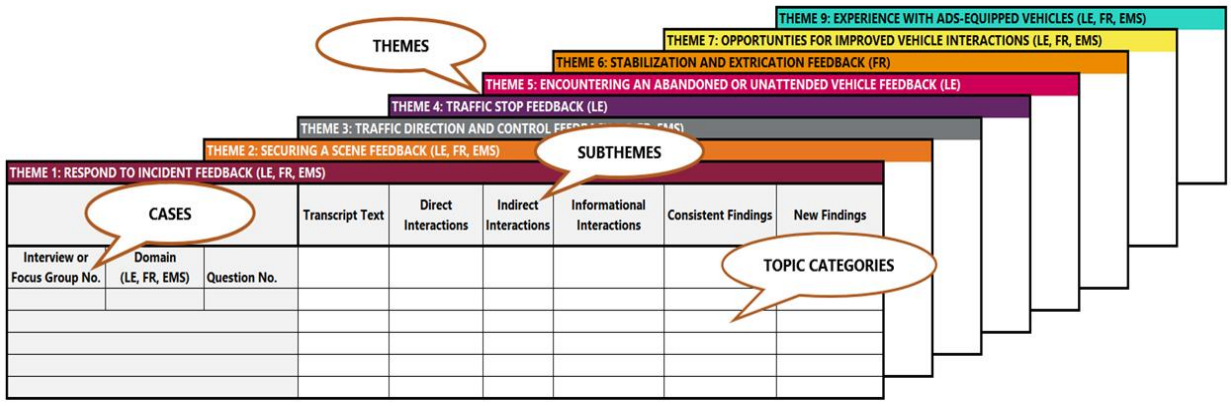



**Figure 16. Illustration of the data analysis process (Adapted from: Ritchie, Spencer, & O'Conner, 2003).**

### 3.3.1 Intercoder Reliability

While the thematic framework and indexing stages were carried out by one primary analyst, the outcomes were reviewed by multiple members of the research team. For any questions that arose, the team discussed the comment and came to an agreement. The team understands that comments are complex and are not mutually exclusive. For example, a comment may reflect several different ideas; thus, individual comments may be included in multiple categories, resulting in useful "piles" of data related to the same ideas (Table 3).

## 3.4 Interpretation of Findings into Meaningful Results

The team considered the findings from the thematic analysis concomitantly with the HTA to better understand the information provided. The HTAs have been updated to reflect additional and/or unique interactions that were identified through this analysis. DO-related questions informed the DO needs assessment discussion presented in Chapters 6 and 7.

## Table 3. Data Analysis Coding Example

| | Abandoned or Unattended Specific Question | Interaction Type | | | Topic Categorization | | Specific Topics | |
|---|---|---|---|---|---|---|---|---|
| **Domain** | **How might your procedure and vehicle interactions change based on vehicle type?** | **Direct** | **Indirect** | **Info** | **Consistent Findings** | **New Findings** | **Traffic Hazard Related** | **Process for Contacting Owner** |
| LE | A tractor trailer would be more of a traffic hazard. Yesterday we had a call on STREET NAME where they were parking a tractor. If it was just a car it would be different, but because of the size they were on the shoulder, they are causing problems for people pulling out of the parking lot. So yeah, you're going to treat a tractor trailer different. | 1 | | 1 | 1 | | 1 | |
| LE | Creating a hazard, we will do whatever we can to call them or with tractor trailers you can usually track the company down pretty easy. They can get in touch with the driver rather than just calling them on your own. | | | 1 | 1 | 1 | 1 | 1 |
| LE | I guess with the tractor trailer, probably in either situation, the officer would typically try and locate somebody [unclear]. In some cases it may be easier to get in touch with a responsible party if it's a tractor trailer. | | | 1 | 1 | | | 1 |

# Chapter 4: HTA of Public Safety Authority and Vehicle Interactions

This section highlights and details the interactions that public safety authorities have with vehicles, including statistics as to the commonality of a specific interaction, scenarios that predicate the interaction, as well as the general process of the interaction. Law enforcement, fire and rescue, and EMS are separated into their own sections; however, some overlap may occur, such as during incident response and traffic management scenarios.

The task analysis diagrams represent the most common procedures associated with vehicle interactions; however, these operations may differ depending upon several variables. There may also be instances where deviation from an established policy or protocol is necessary. Any differences in operations between jurisdictions, levels of authority, or different locales are detailed in the section for each task. It is important to note that agencies of multiple jurisdictions and agencies that respond to a single incident operate under an authority structure called a Unified Command, where the role of commander is shared between two or more entities (Federal Emergency Management Agency, 2013). This impacts how decisions are made. As different agencies arrive at a scene, command may shift, and, therefore, the prioritization of tasks or preference for how certain tasks are performed could change mid-operation (Figure 17). Additionally, any variables perceived to impact the operations of an interaction are listed and detailed. These variables could include weather, road type, available lighting, or the nature of an incident.


**Figure 17. Example of multiple entities at a scene and a redistribution of traffic control tasks from law enforcement to fire and rescue.**

## 4.1 Shared Public Safety Operations

There are a number of tasks that are shared among law enforcement, fire and rescue, and EMS. Those tasks include responding to an incident, securing an incident scene, traffic control, and responding to civilians locked-in or locked-out of their vehicles. The following section details these tasks and highlights any changes to the operation that might occur depending on the public safety domain involved (police, fire and rescue, or EMS).

### 4.1.1 Respond to an Incident

Police departments receive a large volume of calls and prioritize emergency calls using computerized systems unique to the department (Gaines & Kappeler, 2010). The city of Boston, for example, receives 500,000 calls per year and about 20% of those calls require immediate response (Gaines & Kappeler, 2010). Like police departments, fire and rescue departments receive a large volume of incident calls and prioritize these calls using computer-aided dispatch systems. To give a sense of scope, the United States received over 31 million fire and rescue incident calls in 2014, with approximately 14% (4.46 million) of those in response to roadway incidents (Ahrens & Evarts, 2017). EMS entities also routinely respond to a large volume of incidents, with nearly 37 million events in 2009, approximately 28 million of which required EMS transport (Federal Interagency Committee on Emergency Medical Services, 2011).

#### *4.1.1.1 Overall Plan: Respond to an Incident*

The overall goal for any public safety organization that receives an emergency call is to reach the location safely in as little time as possible. This requires emergency vehicle operators to be vigilant while navigating through traffic and to anticipate the reactions of other motorists.

#### *4.1.1.2 Subtask 1: Receive Call from Dispatch*

When an incident such as an automobile crash happens, public safety authorities will receive a call from dispatch informing them of the time and place the incident occurred, along with any other known information. Information may include the number of vehicles involved, the nature of the incident, the condition of the people involved, etc. Using the information provided by dispatch, law enforcement and fire and rescue first responders must decide if an emergency response is warranted, whereas EMS responders are instructed by dispatch if it is an emergency

**Responding to an Incident**

**Domains:**
Law Enforcement
Fire and Rescue
EMS

response (health.ny.gov., 2000). If the incident requires an emergency response (e.g., a motor vehicle crash with injuries), public safety officers will use their lights and sirens to alert nearby motorists to their presence. In both emergency and non-emergency cases, public safety officials will begin to navigate to the scene (Figure 18).

The determination of when to use lights and sirens varies by jurisdiction, department, and domain. In some cases, it is mandated that lights and sirens are used when responding to a scene regardless of circumstances, and in some cases, emergency vehicles may disengage lights and sirens to prevent other drivers from changing their behavior. For example, when needing to pass on the right or on a shoulder, some public safety personnel may disengage lights and sirens so that drivers, who are trained to pull to the right when an emergency vehicle approaches from the rear, will not do so and block their path. They may also disengage lights and sirens when safe to do so around schools to avoid drawing attention or when merging right onto an exit ramp so that drivers do not pull over in front of them. Ambulances may not initiate lights and sirens during medical transport but would also not use excessive speed or violate any traffic laws when in this state (see Appendix D, Item No. 1). The use of horns is variable as well, as drivers of emergency vehicles may engage an air horn to get the specific attention of a nearby vehicle (see Appendix D, Item No. 2).

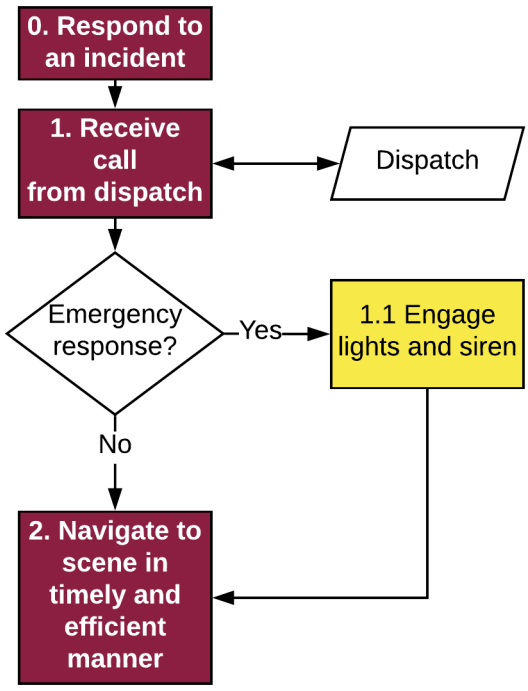



**Figure 18. Respond to an incident**

A variation of vehicle types might be brought to the scene depending on the accessibility of an area or the weather. Various vehicle types include the use of SUVs, ATVs, or all wheel drives. Drivers of larger emergency vehicles, such as fire and rescue apparati and certain ambulances, must be aware of bridge weight and height limitations (see Appendix D, Item No. 3). In rural areas, emergency personnel may respond in their personal vehicles if an incident occurs nearer to their home and it is more efficient to respond directly to an area versus going to a statin first (see Appendix D, Item No. 4).

#### *4.1.1.3 Subtask 2: Navigate to Scene & Subtask 3: Arrive at Scene*

A part of safely and efficiently navigating to the scene involves public safety authorities understanding and reacting to traffic. Even though some state driver's manuals instruct drivers to move over to the right side of the road or onto the shoulder in the presence of an emergency vehicle with its lights and sirens on (Maryland Motor Vehicle Administration, 2016), not all motorists react accordingly. Some motorists stop where they are, others pull over to the left side of the road, and, in some cases, drivers do not yield to the approaching emergency vehicle at all. This requires first responders to anticipate and react to the sometimes unpredictable behaviors of other roadway users (S. Fritz, personal communication, May 31, 2018).

Navigating to the scene requires first responders to determine an optimal route. According to a local SME, the best route could be determined via Global Positioning System (GPS) navigation, be based on personal knowledge of the area, or follow recommended routing provided by dispatch. In circumstances where traffic is congested, slow, or not moving at all, an alternate pathway may be used. This could entail the use of an emergency shoulder and/or lane. Known traffic patterns and times of day that result in increased traffic congestion can influence the route taken (see Appendix D, Item No. 5). Another method is for first responders to slowly drive up the center of two lanes of traffic, having nearby motorists separate to the sides of the road, a procedure colloquially known as "parting the sea" (S. Fritz, personal communication, May 31, 2018).

Traveling to the incident scene often requires public safety officers to navigate intersections. Lieutenant Clifford Kincaid of the Virginia State Police noted that the course curriculum for responding to an incident explains that public safety authorities must use caution when approaching the intersection, and either fully stop or significantly slow down before proceeding

through the road juncture (C. Kincaid, personal communication, May 31, 2018). Interviews with public safety officials (see Appendix D, Item. No. 6) revealed that the cautionary elements of traversing an intersection include screening for hazards and blocked fields of view and making eye contact with other drivers at intersections to ensure they have seen and are reacting to the emergency vehicle's presence and intentions are clear).

While public safety officials are given some latitude on how they reach incident scenes, they are still required to obey all traffic laws (C. Kincaid, personal communication, May 31, 2018). However, there are exemptions to this rule, which are specified by the local authority having jurisdiction departmental policies, and guidelines. Examples of such exemptions include traveling faster than the posted speed limit, traveling in emergency lanes or shoulders, accessing sidewalks (see Appendix D, Item No. 7), and rolling or not fulling stopping at intersections or stop signs. According to Captain Kris Weaver of the Montgomery County Virginia Sherriff's Office, each public safety official uses their own discretion on how best to exercise these exceptions with due regard 5 (K. Weaver, personal communication, May 30, 2018). If not expected to be first on scene, a public safety official may respond less urgently and more safely (see Appendix D, Item No. 8).

If it is reported that hazmat materials are on scene, subsequent responders may slow their response as the presence of hazmat would prevent them from operating until dealt with by a qualified hazmat team (see Appendix D, Item No. 9). Conversely, hazards such as leaking fuel or downed power lines may exacerbate the urgency of a response (see Appendix D, Item No. 10).

Both Captain Weaver and Deputy Casey Carroll of the Montgomery County Virginia Sherriff's Office pointed out via personal communication that police, for instance, are trained to "clear" an intersection, even if signaled red, by slowing to a speed where an urgent stop is possible if necessary prior to proceeding through the intersection (May 31, 2018). Fire and rescue and EMS have similar policies for traversing intersections (health.ny.gov, 2000). Some first responders have access to what is known as a "traffic preemptive device," which can manipulate signalized traffic control in the path of an emergency vehicle (S. Fritz, personal communication, May 31, 2018). This can halt conflicting traffic and allow an emergency vehicle easier access through an intersection.

In some cases, emergency vehicles may need to drive off the roadway to access a scene or to avoid debris caused by a scene. This may require an emergency vehicle to briefly drive into an oncoming lane (see Appendix D, Item No. 11) or to leave the roadway completely and drive onto a sidewalk or through a narrow alleyway. Some roundabouts or traffic circles are constructed to allow large vehicles to conveniently drive through their center and emergency responders may utilize this feature of a traffic circle to expedite their navigation through it (see Appendix D, Item No. 12).

In addition to intersections and traffic circles, there are other areas where emergency vehicle drivers need to proceed with extra caution. School zones, areas where pedestrians and cyclists are common, and, in the evening, areas near bars or pubs will require responders to scan the environment more thoroughly and perhaps reduce their vehicle speed in these areas. Special attention is also given to rural areas where slow moving tractors may need to access sections of the roadway (see Appendix D, Item No. 13).

During periods of inclement weather or if the road surface is slippery, drivers of emergnecy vehicles will increase their following distances from other traffic so if they need to stop or slow suddenly, the risk of hitting a vehicle is lessened (see Appendix D, Item No. 14).

**Figure 19. Example of an unmarked car with lights engaged.**

Many law enforcement jurisidictions incorporate the use of “unmarked” vehicles, both sedans and SUVs. These vehicles appear as civilian vehicles in that they do not have any obvious striping, wording, or markings that indicate they are police vehicles. These vehicles typically do have emergency lighting placed on the interior of the vehicle that becomes visible to other motorists when activated (Figure 19). Similarly, these vehicles also use the same sirens as their marked counterparts. These vehicles are regarded by law enforcement as being less identifiable or visible, by design, but also can lead to difficulties in navigating traffic during an emergency response (see Appendix D, Item No. 15). They may need to manuever to be visible in the mirrors

of vehicles, especially larger vehicles, to be seen.This is true especially for intersections where the profile markings of the vehicle are absent and lighting is minimal, resulting in cross traffic being unable to determine it is a police vehicle engaged in emergency response (Figure 20). These various types of procedures in responding to an incident are outlined in Table 4.

**Table 4. Interaction Types, Descriptions, and Contingencies for Responding to an Incident**

| Task | Interaction Type | Interaction Description | Contingency or Standard Procedure |
|---|---|---|---|
| 1.1 | Indirect | Engage lights and siren | Standard operating procedure |
| 2.1 | Informational | React to traffic | Standard operating procedure |
| 2.2 | Indirect | Use alternative path (with lights and siren engaged) | If traffic is not moving or is moving slowly |
| 2.3 | Indirect | Drive through center of traffic (with lights and siren engaged) | If traffic is not moving or is moving slowly and no alternative path available |
| 2.1.2 | Indirect | Use preemptive traffic device | If available |

| | |
|---|---|
| **Direct:** | Physical interaction between a public safety officer and the subject vehicle |
| **Indirect:** | Communication via lights and sirens, maneuvering by positioning public safety vehicle for traffic control and access |
| **Informational:** | Public safety officer gathers information (e.g., electronically scans license plate to determine ownership) |

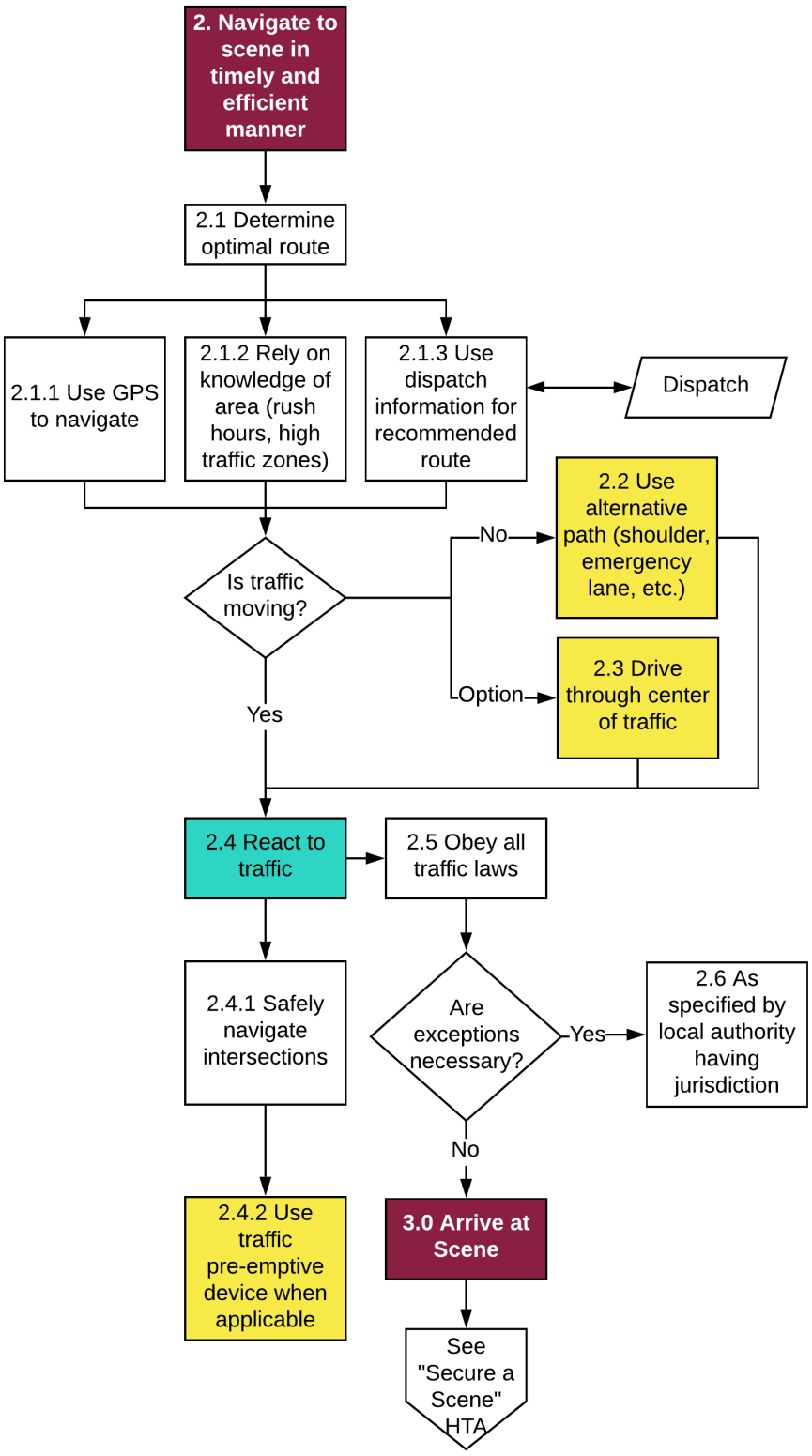



**Figure 20. Respond to an incident subtasks 2 and 3.**

### 4.1.2 Secure a Scene



**Domains:**
Law Enforcement
Fire and Rescue
EMS

Upon arriving at a scene, such as in the case of a vehicular incident, the first duty of law enforcement is to relay via radio communication the precise location of the incident through use of street names, mile markers, or nearby interchanges (K. Weaver, personal communication, May 30, 2018). Next, the first officer on the scene relays to the dispatcher the number of vehicles and types of vehicles involved in the incident (C. Carroll, personal communication, May 26, 2018). This exchange is informational and requires the first responder to ascertain the information by observing the scene visually, counting the number of vehicles, and relaying the general vehicle type(s), such as sedan, pickup, SUV, van, medium or heavy duty, or tractor trailer. It is up to the officer as to how much detail is relayed during this exchange and this is somewhat dependent upon the officer's familiarity with vehicle types and how well they can assess the scene.

During incident responses, fire and rescue are generally not the first public safety authorities to arrive at the scene. As such, dispatch will have already relayed all relevant available scene information, such as number, type, and orientation of vehicles, as well as information about the condition of any vehicle occupants (S. Fritz, personal communication, May 31, 2018). However, if fire and rescue were first on the scene, similar to responding police, they would relay via radio communication the precise location of the incident through use of street names, mile markers, or nearby interchanges. The next task would be to assess the scene by gathering information about the number of people involved, number of people injured, vehicles involved, whether extrication is necessary, and whether any additional resources are needed at the scene. This information would be relayed to dispatch on an ongoing basis until the scene was clear (S. Fritz, personal communication, May 31, 2018).

EMS is rarely the first public safety authority to arrive at a scene, as their dispatch service will typically notify and route the EMS provider to the incident. Once on scene, the EMS will gather information about the number of people injured and primarily focus on patient (i.e., any injured occupant) safety and care. If EMS happens to be first on scene, they will provide treatment to any involved patient immediately and sometimes without any scene protection such as cones, flares, or blocking vehicles (see Appendix D, No. 16 and Appendix D, No. 17).

#### *4.1.2.1 Overall Plan: Secure Scene*

The overarching goal of this task is to gather and report information about the incident, determine if additional resources are required, make the scene safe for first responders by blocking and diverting traffic, and continually assess the scene and patient(s).

#### *4.1.2.2 Subtask 1: Receive Information about Incident*

In this task, information received from first responders informs fire and rescue and EMS how to prepare their response to the incident. More specifically, information is collected about the number of people involved, the number of people injured, and whether extrication is necessary and relayed to dispatch.

During this stage, there are no interactions between public safety authorities and the vehicle prior to arriving on scene. Furthermore, as shown in Figure 21, information relayed from dispatch to fire and rescue (e.g., type of accident, vehicles involved, and any information pertaining to occupant number or condition) will inform the degree of response in terms of number of response vehicles.

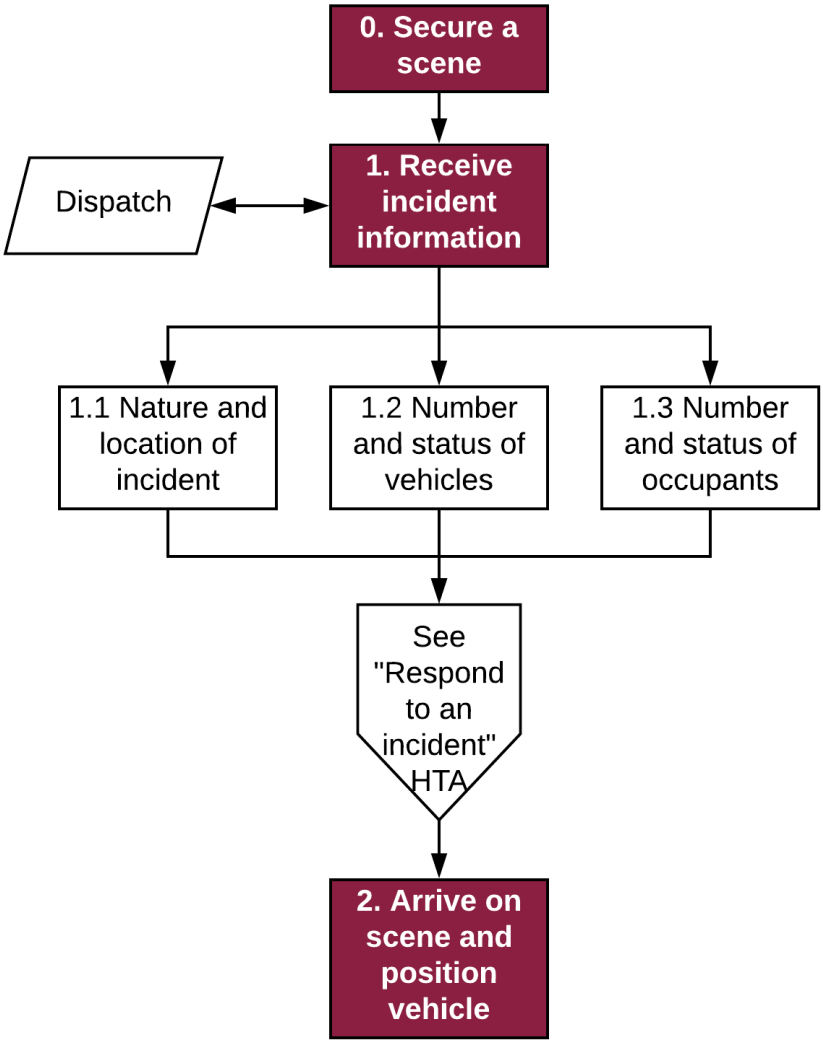



**Figure 21. Secure a scene subtask 1.**

Some jurisdictions and agencies rely on an incident classification system to describe the amount of time and types of equipment necessary for an incident. In general, a major classification takes 2 or more hours, a classification of intermediate takes between 30 minutes and 2 hours, and a minor classification takes less than 30 minutes (National Highway Traffic Safety Administration, 2009; Wisconsin Department of Transportation, 2014). Scene durations increase with each additional vehicle, occupant, or if a larger vehicle is involved (see Appendix D, Item No. 18). It is not uncommon for “political pressures” to rush an operation in order to reopen a roadway, per interviews with public safety officials (see Appendix D, Item No. 19).

#### *4.2.2.3 Subtask 2: Arrive on Scene and Position Vehicle & Subtask 3: Prioritize Actions on Scene*

The next task involves the arriving team setting up temporary traffic control. The first step is for the fire department to park their apparatus (e.g., fire truck). This procedure entails positioning the apparatus in such a way that both the incident lane and usually one additional lane are blocked. Furthermore, the apparatus is parked at least 50 feet from the scene and may be angled 45 degrees to the travel lane. There are two reasons for this procedure: 1) to increase the apparatus' salience, and 2) to create a safety shadow for workers on the incident scene (FDNY, 2016). The angle and positioning of the vehicle are not always the same. Some agencies and jurisdictions have found that angling the vehicle decreases the visibility of its lighting system. Others indicated that the situation would dictate how to park the vehicle but if attempting to block a lane of travel, they would park in the lane without their vehicle angled. Team members will also note other potential hazards, such as restricted or impaired sightlines (e.g., due to such things as roadway geometry, smoke, fog) and the potential for secondary crashes, defined (Moore, Giuliano, & Cho, 2004) as incidents that "occur as traffic is exposed to either the queue or to a queue boundary that forms as a result of the primary event and any associated chain reaction events" (p. 218).

Once the apparatus is parked, the crew will begin to lay out warning devices (e.g., cones, flares) to alert other vehicles of the incident scene, and to taper the lanes and create an additional buffer zone (Table 5) for the fire and rescue team using local department guidelines (FDNY, 2016), or procedures laid out in the Manual on Uniform Traffic Control Devices (MUTCD) (Rogers Fire Department, 2017). Other first responders arriving after the apparatus is in position will generally park their vehicles on the shoulder or downstream of the incident. The incident itself may be surrounded with police tape if a criminal incident has occurred (see Appendix D, Item No. 20).

**Table 5. FDNY Warning Device Placement Guide**

| Fastest Speed Expected (MPH) | Minimum Distance to Furthest Flare (Feet) |
|---|---|
| 20 | 100 |
| 30 | 150 |
| 40 | 220 |
| 50 | 310 |
| 60 | 420 |
| 70 | 550 |

Prioritizing the scene is the next primary task. If police are first on scene, after they have positioned their vehicle to block traffic, their priority is investigating the crash (K. Weaver, personal communication, May 30, 2018). In Virginia, state troopers are explicitly trained to never attempt to direct traffic and investigate the crash simultaneously (C. Kincaid, personal communication, May 31, 2018). Once fire and rescue arrive on scene, police will typically begin actively directing traffic after exchanging information about the scene gleaned by the first on-scene officer (K. Weaver, personal communication, May 30, 2018).

As indicated in Figure 22, responders first on the scene will initially park to protect the scene and then go straight to the scene and assess vehicle occupants. If not first on the scene, responders' first priority is parking their vehicles on the shoulder or out of the way. There is a continuous feedback loop about being first on scene, as additional personnel can shift duties depending on the department, agency, or jurisdiction.

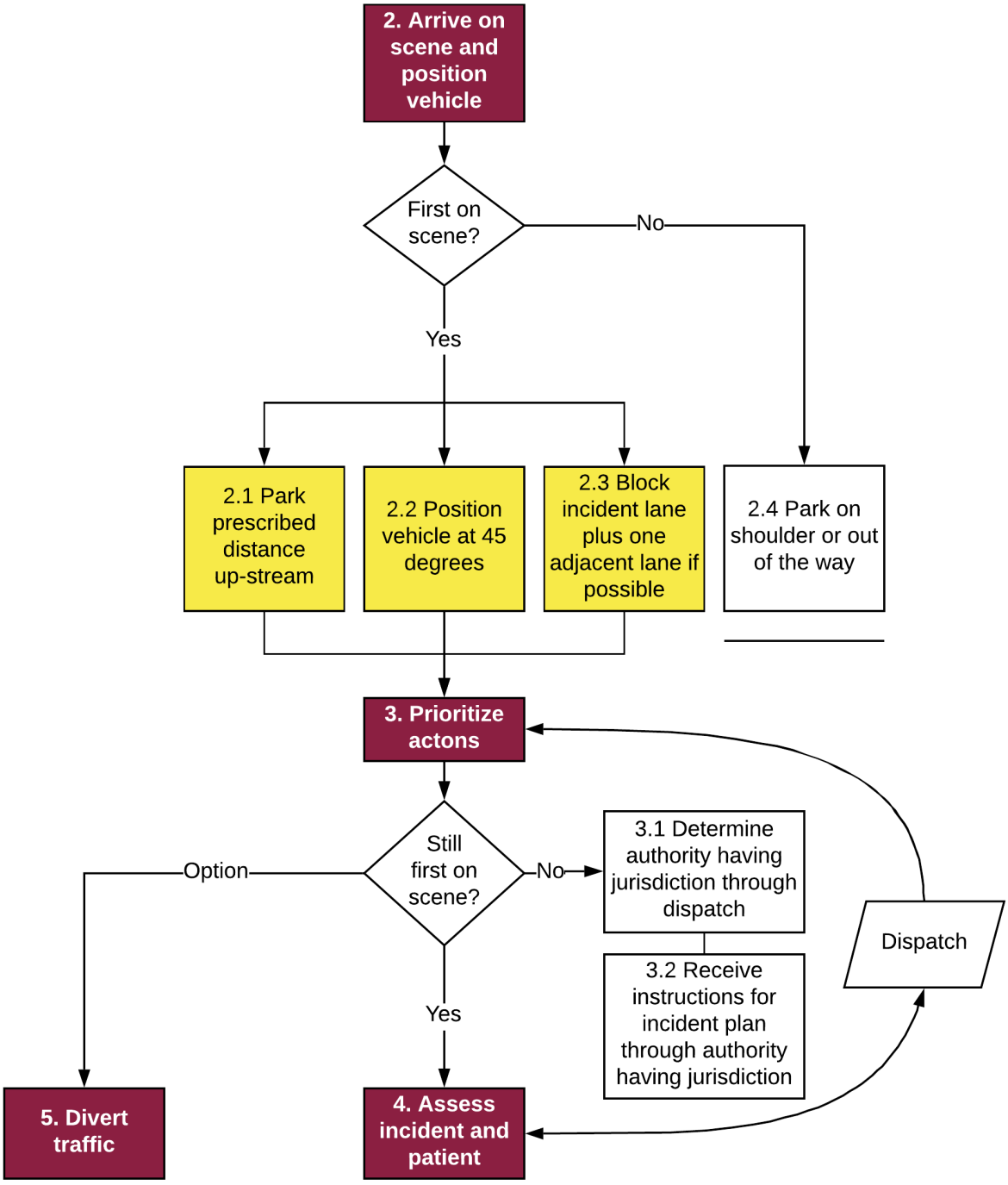



**Figure 22. Secure a scene subtasks 2 and 3.**

#### *4.2.2.4 Subtask 4: Assess Incident & Subtask 5: Divert Traffic*

The next action is to assess the incident scene for any hazards, both those that are directly involved with the incident (e.g., hazardous materials, fire) and any that could create the potential for secondary collisions (FDNY, 2016). While assessing hazards at the scene, both fire and rescue as well as law enforcement use this information to attempt to determine the cause of the crash (see Appendix D, Item No. 21). Another aspect of assessing the incident is to account for the occupants of the vehicle(s) involved in the incident. This requires first responders to visually inspect the vehicle(s) involved and scan the nearby area for persons who may have wandered away from the immediate incident area or been ejected from the vehicle. First responders, in general, will "size-up" the scene where they will use the visual information on hand to verify, confirm, or clarify information provided by dispatch prior to arriving on scene. This allows for subsequent responders to arrive with more accurate information, which can impact the personnel and equipment brought on scene (see Appendix D, Item No. 22). After scanning the area, the public safety officials confer with all bystanders to get a count of any people involved in the incident. Some emergency responders may carry specialized equipment, such as infrared or thermal cameras, that allow them to scan the area for heat signatures in low light settings (S. Fritz, personal communication, May 31, 2018).

After all occupants have been accounted for, police will initiate an investigation of the crash. This involves an inspection of the area and the vehicles as well as interviewing occupants and eye-witnesses at the scene. A first responder's next step is to assess the vehicle, starting by determining whether it is in a hazardous location; for example, in the lane of travel. If it is in a hazardous location and the vehicle can be moved to safer location, the public safety authorities will move the vehicle, either by physically pushing the vehicle, asking the driver to move it or, if necessary, the first responder could enter the vehicle and drive it a short distance to a safer place (C. Kincaid, personal communication, May 31, 2018). Some police agencies, such as the Virginia State Police, permit the use of a departmental vehicle's push-bar or push-bumper to move vehicles involved in crashes away from the roadway in cases where the vehicle has been cleared of occupants and can roll freely (W. Blydenburgh, personal communication, May 31, 2018). Regardless of whether the vehicle is moveable or not, if extrication is required, the next step is to stabilize the vehicle to prevent it from moving. See section 4.3.1 Stabilize Vehicle for details on how to ensure the vehicle is stable during an incident.


**Figure 23. Example of advanced warning devices and messaging.**

Diverting traffic is an important step, both in protecting the first responders working at the scene, and in ensuring the safety of other roadway users who come across the scene. Federal law requires anyone working alongside a highway to wear high-visibility apparel (*MUTCD*, 2009). In some circumstances, such as incidents that occur on a two-lane or bi-direction roadway, first responders may need to manually direct traffic with hand signals, flags, or if at night, flashlights. Manual direction can be used in addition to warning devices (e.g., cones, flares) (Houston Police Department, 2004; Wisconsin Department of Transportation, 2014). Per personal communication with Virginia State Police Lt. William Blydenburgh regarding traffic direction and control policy, in the event that advanced traffic diversion is necessary, a state's department of transportation or a highway contractor may be called to provide advance warning devices such as LED message boards, cones, and flagging crews (May 31, 2018; Figure 23). If in need of a medical helicopter, traffic may need to be cleared from an area to make room for a landing (see Appendix D, Item No. 23).

In the event of a larger operation that may involve larger or hazardous vehicles, a staging area may be utilized, and these scenes typically require a longer time to clear from the roadway. Depending on the time of day, the number of resources may vary which can impact the duration of a scene's operation (see Appendix D, Item No. 24). In rural areas, it is not uncommon for a passer-by to be requested to assist with traffic control at a scene until more help arrives (see Appendix D, Item No. 25).

To reduce traffic to an area where a major scene is in operation, law enforcement may resort to social media outlets to broadcast messages and warnings to avoid areas (see Appendix D, Item

No. 26). A more extensive overview of traffic direction and control can be found in section 4.1.3 Traffic Direction and Control.

As Figure 24 shows, subtasks 4 and 5 can be conducted in parallel but depend on agencies at the scene. The priority for any first responder is to scan for hazards, scan for occupants, and assess the vehicle—in roughly that order—while relaying all that information to dispatch for subsequent responders. If multiple agencies converge on a scene, the traffic control component will typically be performed by on-scene law enforcement. If a scan for occupants results in a determination that an extrication is necessary, then both vehicle extrication and stabilization will need to be performed. While most extrications are performed by fire and rescue teams, law enforcement may attempt to extract an occupant and/or shut off the engine on their own in dire circumstances. For details of these operations, see section 4.3.1 Extricate Occupant.

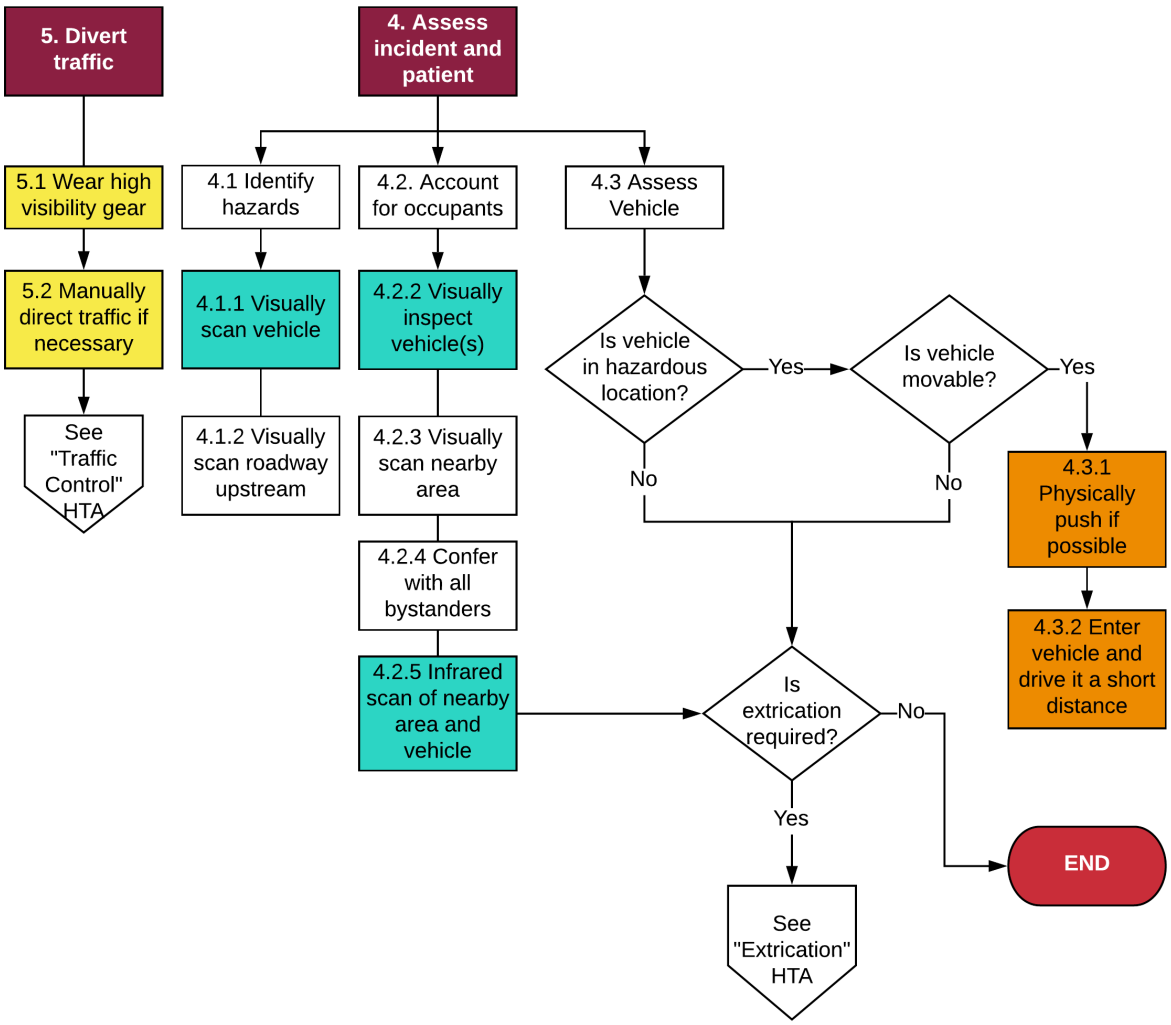



**Figure 24. Secure a scene subtasks 4 and 5.**

As Table 6 shows, interactions between public safety authorities and vehicles include direct, indirect, and informational interactions. The indirect interactions center on positioning the vehicle at the scene to warn oncoming traffic that there is an incident ahead and that merging lanes is necessary; lanes are also blocked to protect responders. Similarly, high-visibility gear is used when traffic is manually controlled and directed so drivers can easily distinguish public safety authorities. The informational interactions are centered on inspecting the vehicle, visually or with infrared if available, to search for occupants involved in an incident. The direct interactions with the vehicle are few and may not be permissible depending on the jurisdiction or agency. Those direct interactions include physically pushing a vehicle off the roadway or driving it a short distance.

**Table 6. Interaction Types, Descriptions, and Contingencies for Respond to an Incident Subtask**

| Task | Interaction Type | Interaction Description | Contingency or Standard Procedure |
|---|---|---|---|
| 2.1 | Indirect | Park prescribed distance upstream from scene | Standard operating procedure |
| 2.2 | Indirect | Position vehicle | Standard operating procedure |
| 2.3 | Indirect | Block incident lane plus one adjacent lane if possible | Standard operating procedure |
| 4.1.1 | Informational | Visually scan vehicle(s) for hazards | Standard operating procedure |
| 4.2.2 | Informational | Visually inspect vehicle(s) for occupants | Standard operating procedure |
| 4.2.5 | Informational | Use infrared scanning on vehicle(s) and nearby area to search for occupants | If technology is available |
| 4.3.1 | Direct | Physically push vehicle from roadway | If vehicle is in a hazardous location and can be moved |
| 4.3.2 | Direct | Enter vehicle and drive it a short distance to safety | If vehicle is in a hazardous location, can be moved, and driver grants permission |
| 5.1 | Indirect | Equip high-visibility gear | Standard operating procedure |
| 5.2 | Indirect | Manually direct traffic | If situation requires traffic to be manually controlled around a scene |

**Direct:** Physical interaction between a public safety officer and the subject vehicle
**Indirect:** Communication via lights and sirens, maneuvering by positioning public safety vehicle for traffic control and access
**Informational:** Public safety officer gathers information (e.g., electronically scans license plate to determine ownership)

### 4.1.3 Traffic Direction and Control

Public safety officials may need to manually direct traffic in a number of circumstances, such as at special events, during man-made or natural disasters, in adverse weather conditions, when there is fire, smoke, or fog, at traffic crash scenes, or when there are damaged or malfunctioning traffic control devices (Florida Highway Patrol, 2015). When directing traffic at night or during periods of inclement weather, a traffic controller will utilize flashlights, reflective clothing, and flares to increase their visibility. Depending on the situation, police may use whistles or voice commands to address traffic (Florida Highway Patrol, 2015; Seattle.gov, 2003). Police may manually override traffic control devices when directing traffic by using uniform hand signals and gestures (Florida Highway Patrol, 2015; Houston Police Department, 2004; Seattle.gov, 2003). In other words, a traffic signal may show an active green light, but traffic controllers are manually signaling traffic to stop.

#### *4.1.3.1 Overall Plan: Perform Traffic Direction and Control*

**Traffic Direction and Control**

**Domains:**
Law Enforcement
Fire and Rescue
EMS

The ultimate goal of this task is to communicate through hand gestures, body language, whistles, flashlights, or batons to direct public motorists.

#### *4.1.3.2 Subtask 1: Determine Location & Subtask 2: Setup Warning Signals*

Where to divert or reroute traffic is an important consideration to the operation and is decided prior to the operation. In some cases, it may be necessary for traffic to be routed through areas that are non-intuitive or that violate the road's design, such as into an oncoming traffic lane, across bike lanes, or through parking lots. In areas prone to congestion, such as bridges and tunnels, traffic may be turned around at the scene and diverted in the opposite direction (i.e., against prescribed traffic direction). Certain reroutes may employ the use of highway medians typically reserved for authorized vehicles or require U-turns where those maneuvers are otherwise not allowed. During periods of inclement weather, such as that of snow, traffic control prefers to route traffic through areas that have already been cleared by plows (see Appendix D, Item No. 27). In general, urban areas give more reroute options for public safety authorities to select from (see Appendix D, Item No. 28). Traffic volume and time of day factor greatly into where traffic may be rerouted.

Considerations must also be given to the type of traffic being diverted and where it is being routed to. For example, small bridges may have a weight capacity and some underpasses may have a low clearance that could prevent larger vehicles from using those routes. Larger vehicles may be incapable of making the same maneuvers of smaller vehicles and in some cases are stopped completely until a roadway is clear for them to continue. Public safety officials may approach the vehicle to ask a driver how comfortable they are with a maneuver or if they are capable of making certain maneuvers (see Appendix D, Item No. 29 and No. 30).

The primary aspect of conducting traffic control requires being visible. To do so, law enforcement and fire and rescue teams are required to wear retroreflective vests whenever on a

roadway to be visible to oncoming motorists. The same rules apply to several EMS agencies; however, not all ambulance services use retroreflective vests on scene. Different colors of gloves, commonly glow-in-the-dark gloves, are used when directing traffic; however, during extreme temperatures it is typical for traffic controllers to wear whatever is warmest. According to some first responders, not all retroreflective gear issued by departments meet ANSI/ISEA 107-2015 standards (see Appendix D, Item No. 31). During periods of inclement weather or low temperatures, public safety officials may inadvertently cover their reflective materials with other overcoats or garments in an attempt to stay warm, thus affecting their visibility (see Appendix D, Item No. 32).

The location that requires traffic control may be predetermined if a special event, such as a concert or sporting event, has been scheduled and police presence has been arranged to provide that control. Other instances that may prompt traffic control unexpectedly include crashes, malfunctioning traffic signals, or disasters of various kinds. In those situations, the location that warrants traffic control will be relayed to an officer via dispatch (Seattle.gov, 2003). Qualified fire and EMS officials who perform traffic control typically do so at incident scenes rather than at special or preplanned events (Seattle.gov, 2003).

If providing traffic direction and control at a crash scene, the traffic controller's next task is to signal oncoming traffic with the use of flares or other advanced warning devices. The general guidelines used for placing flares in relation to a scene are listed in Table 7, though the positioning for flares is not always regulated or enforced (see Appendix D, Item No. 33). For any speed zone, if flares are to be used to channel traffic from one lane to another, they are to be placed 20 feet apart to reduce the opportunity for a motorist to become confused and drive between them (Greenbelt Police Department, 2007). In addition to flares, an advanced warning may require police to request assistance from a transportation department to access cones, barrels, and barricades. For example, Deputy Casey Carroll of the Montgomery County Virginia's Sherriff's Office stated that, in Virginia, requests are often made of the Virginia

**Figure 25. LED disc (left) and standard flare (right)**

Department of Transportation to place LED message boards and buffer vehicles to warn approaching motorists to proceed with caution (C. Carroll, personal communication, May 26, 2018). Some law enforcement and fire and rescue agencies have replaced standard flares with LED discs that are used similarly (Figure 25). Reasons given for the shift from flares to the LEDs included their reusability, enhanced visibility, and reduced risk of igniting when in contact with fuel on the roadway (see Appendix D, Item No. 34).

Emergency vehicles with active lighting may also be used to provide an advanced warning to approaching traffic. The amount of advanced warning provided largely depends on available resources for a jurisdiction (see Appendix D, Item No. 35).

**Table 7. Flare and LED Placement for Traffic Direction and Control (adapted from Greenbelt Police Department, 2007)**

| Highway Speed | Distance from Scene | Placement |
|---|---|---|
| 55 MPH | 375 feet | Every 40 feet |
| 45 MPH | 300 feet | Every 40 feet |
| 35 MPH | 200 feet | Every 30 feet |

Figure 26 shows the tasks associated with subtasks 1 and 2 within the traffic direction and control task analysis. A preplanned event typically involves law enforcement ushering slow moving traffic through an area and does not require advanced warnings aside from officers parking their vehicles upstream with the emergency lighting activated. The use of the emergency lighting systems and flares, if necessary, indirectly interacts with nearby motorists as a warning for them to proceed with caution.

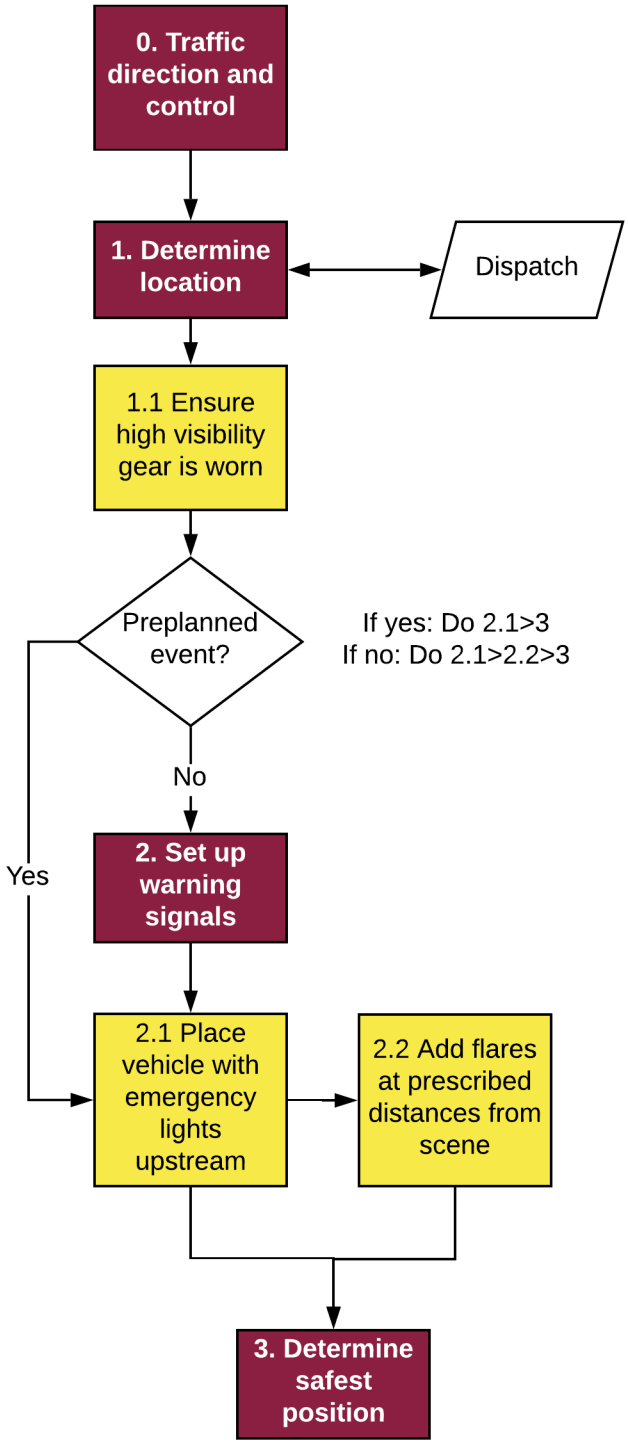



**Figure 26. Traffic direction and control subtasks 1 and 2.**

#### *4.1.3.3 Subtask 3: Determine Safest Position*

The next task for traffic direction and control is to determine the best position. At an intersection, the options are the center of the intersection or at one of the corners. The center of the intersection provides the greatest visibility but is perceived to be the most hazardous. In situations where a busy intersection needs manual control, the use of two public safety officials may be employed. The center is typically selected when the traffic signals are non-functioning or if the flow of traffic is slow. A corner position is used when pedestrian traffic is heavy or if the flow of traffic can be regulated by standing a few feet from the curb (C. Kincaid, personal communication, May 31, 2018). This position provides the greatest safety to the traffic controller and better control over pedestrians (Greenbelt Police Department, 2007). For non-intersection positioning, traffic control should be performed in the least hazardous location, preferably standing near the edge of the roadway or at a location where both directions of travel can see the traffic controller (C. Carroll, personal communication, May 26, 2018). For example, positioning at the apex of a curve or the crest of a hill will maximize visibility from both directions (C. Carroll, personal communication, May 26, 2018; C. Kincaid, personal communication, May 31, 2018). When possible, a traffic controller may use a parked vehicle as a barricade to protect from a specific direction of traffic and to bolster their visibility (see Appendix D, Item No. 36).

On higher speed roadways such as interstates and divided highways, traffic control is typically conducted using advanced warnings, vehicles, and message signs as opposed to people for the sake of safety and practicality (see Appendix D, Item No. 37). Rumble strips may be placed on the roadway as an advanced warning to indicate to vehicles to be prepared to stop (see Appendix D, Item No. 38).

During inclement weather, such as electrical storm, high winds, or heavy rain a traffic control operation may be abandoned. During this time, a road may be closed until conditions clear (see Appendix D, Item No. 39).

The bulk of the interactions to take place during the traffic direction and control operation will be in subtask 4, as subtask 3 is comprised mostly of contingencies where police will determine the safest position from which to perform traffic control (Figure 27).

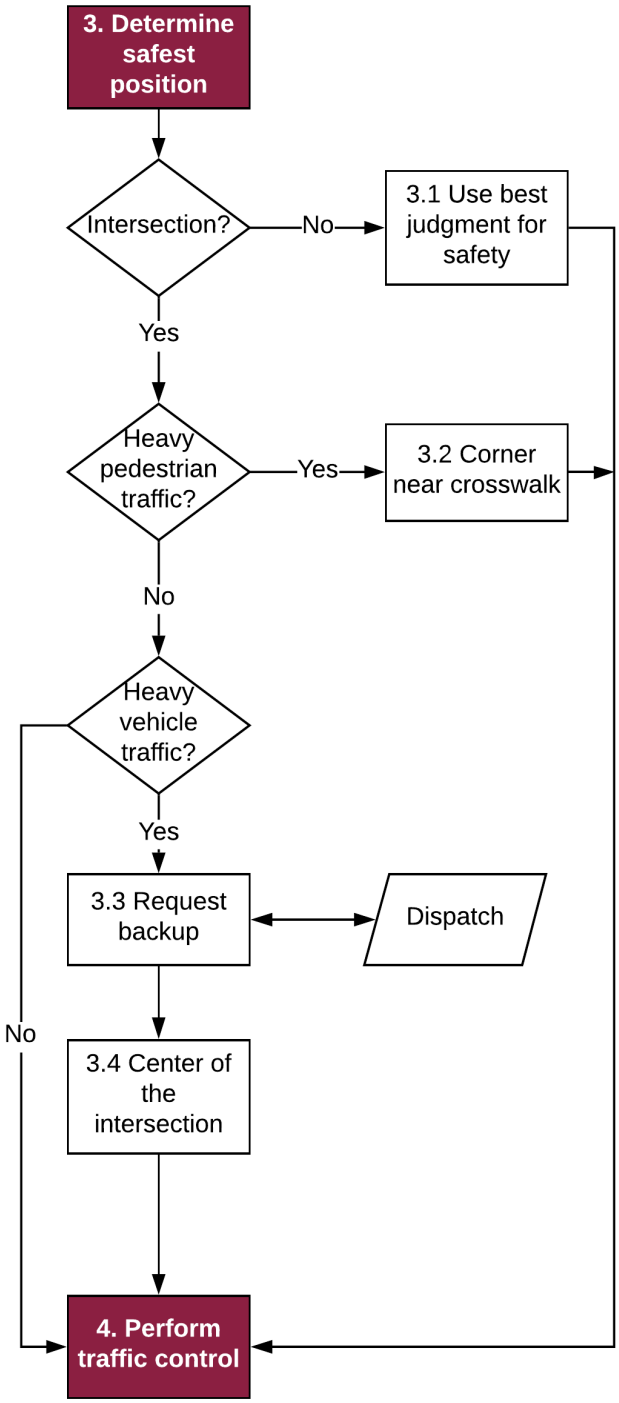



**Figure 27. Traffic direction and control subtask 3.**

#### *4.1.3.4 Subtask 4: Perform Traffic Control*

To direct a vehicle to either stop or move, the first task is to ensure that the motorist's attention is on the traffic controller. The first step in this interaction is to make eye contact with a driver of an approaching vehicle, use a whistle, and perform deliberate hand movements (Florida Highway Patrol, 2015). When not gesturing to a vehicle, traffic controllers are instructed to stand at ease while facing traffic with their hands to their side. When directing traffic, their shoulders should be in line with the flow of traffic (Greenbelt Police Department, 2007). While most public safety officials are taught to direct traffic the same way, there may be individual variations in how certain aspects are conducted (see Appendix D, Item No. 40).

To stop a vehicle, traffic controllers point at the vehicle and look at the driver until eye contact is made (Florida Highway Patrol, 2015). Then one hand is raised with palm facing the driver until the driver comes to a stop (Florida Highway Patrol, 2015; Seattle.gov, 2003). Using the other hand, a controller may point to the exact location they intend the driver to stop. On high-speed roadways, controllers are instructed to face the traffic they intend to stop and extend both hands over their head with palms facing the oncoming motorists (Figure 28) (Florida Highway Patrol, 2015). To indicate to a driver that they should slow down, the controller will face traffic, point at the driver with their right hand and slowly pump the left hand up and down away from their body in a ball dribbling gesture (Houston Police Department, 2004).

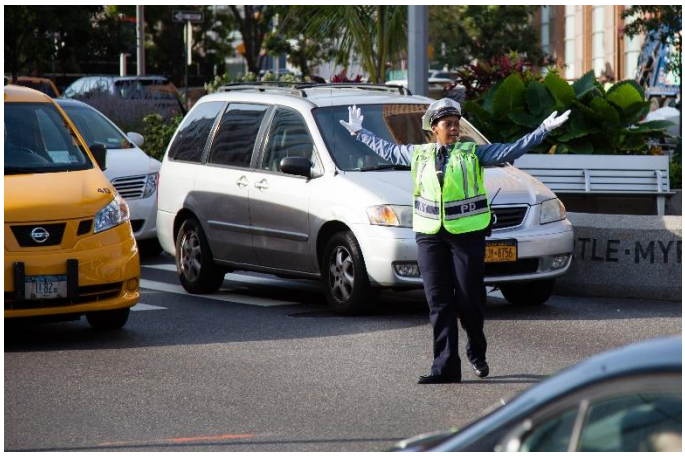


**Figure 28. Example of traffic direction and control.**

To initiate traffic flow, a traffic controller will point at the vehicle and look at the driver until eye contact is made and then rotate their hand up and over their chin, toward their body, bending their arm at the elbow. To direct traffic either left or right, traffic controllers initiate movement with the previously described gesture and then point to the direction of the turn the driver should make (Florida Highway Patrol, 2015; Greenbelt Police Department, 2007).

Police are sometimes issued whistles or bullhorns to supplement their communication with drivers. Generally, one long blast signals stop, two short blasts signal proceed, and three short blasts signal slow down (Houston Police Department, 2004). To gain a motorist's attention, police may use several short blasts. In addition to whistles, police may use flashlights or signal wands at night or during inclement weather conditions. Flashlights can be converted into traffic wands by using extensions placed over the end (see Appendix D, Item No. 41). Gestures are slightly different with flashlights or signal wands. To signal a driver to move, officers point their flashlight at the driver, along with a whistle indication, and direct the beam downward to the ground and in the direction of intended travel. Pointing a flashlight at the driver is not always recommended as it may briefly disorient the motorist (see Appendix D, Item No. 42). To stop a motorist with a flashlight, one hand should face the driver with the palm out to indicate stop while the flashlight hand sweeps back and forth aimed at the ground at a 45 degree angle (Greenbelt Police Department, 2007; Houston Police Department, 2004). If using traffic wands, police will form an "X" with the wands by crossing them to indicate stop (see Appendix D, Item No. 43). Police are made aware that positioning themselves away from any lighting behind them, including their own emergency vehicles, is ideal for visibility (Florida Highway Patrol, 2015). Not all departments are issued whistles and these personnel resort to verbal commands and yelling to supplement gestures and signaling (C. Carroll, personal communication, May 26, 2018). Additional verbal communication may take place if a driver in a queue stops near the traffic controller to ask for a clarification of the instructions or to ask further directions (see Appendix D, Item No. 44).

The traffic control gestures and signals performed by anyone conducting traffic control are considered indirect interactions (Figure 29).

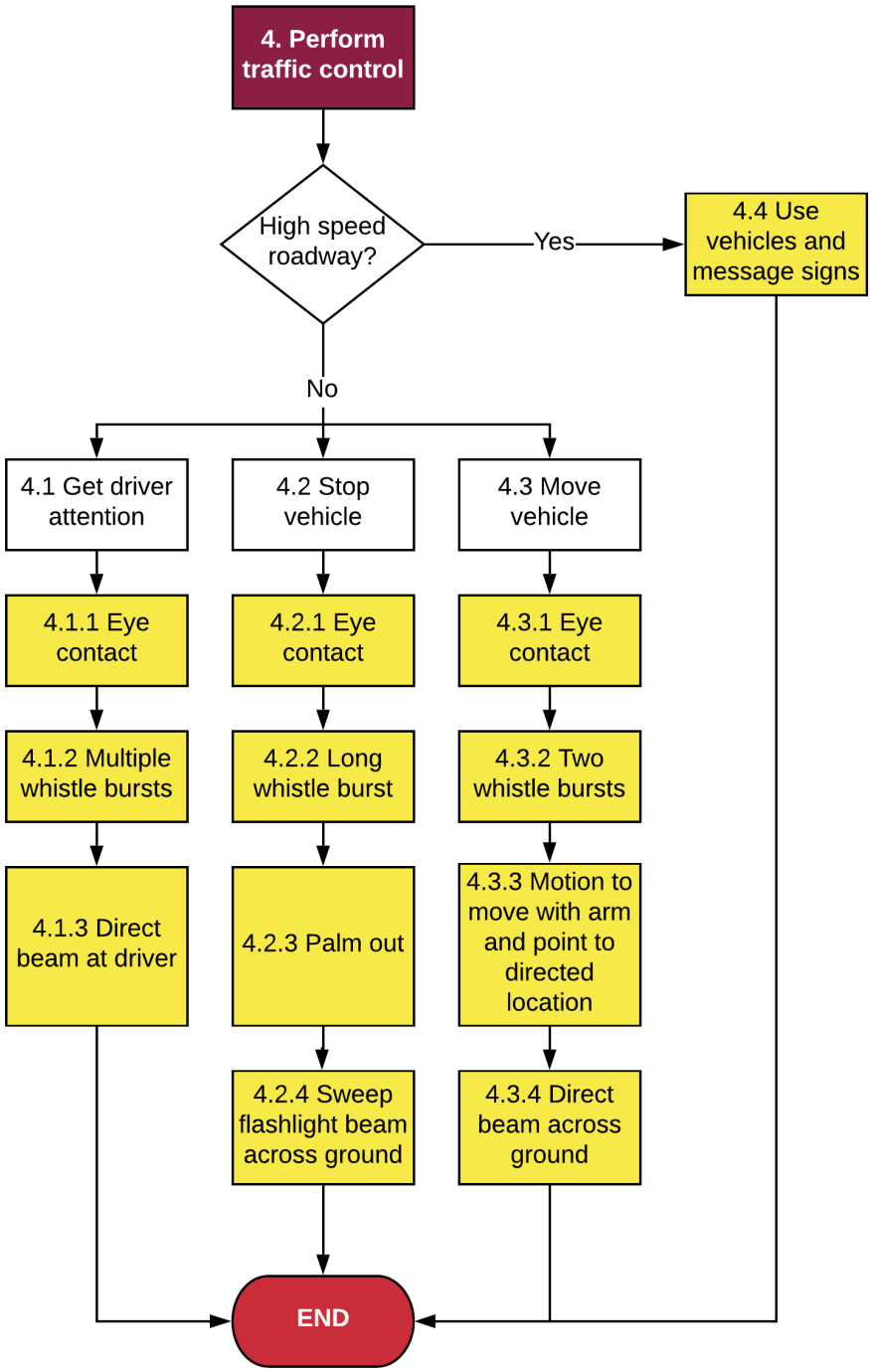



**Figure 29. Traffic direction and control subtask 4.**

Table 8 highlights the different types of interactions public safety officials have with vehicles during traffic direction and control operations. During a typical operation, no informational or direct interactions occur, as the ultimate goal of the operation is to maximize traffic flow.

**Table 8. Interaction Types, Descriptions, and Contingencies for Traffic Direction and Control**

| Task | Interaction Type | Interaction Description | Contingency or Standard Procedure |
|---|---|---|---|
| 2.1 | Indirect | Place vehicle with emergency lights activated upstream | Standard operating procedure |
| 2.2 | Indirect | Add flares at prescribed distances from scene | If deemed necessary by incident command |
| 4.1.1 | Indirect | Eye contact | Standard operating procedure |
| 4.1.2 | Indirect | Multiple whistle bursts | Gain driver's attention |
| 4.1.3 | Indirect | Direct flashlight beam at driver | Gain driver's attention when visibility is low |
| 4.2.1 | Indirect | Eye contact | Standard operating procedure |
| 4.3.1 | Indirect | Eye contact | Standard operating procedure |
| 4.2.2 | Indirect | Long whistle burst | Standard operating procedure |
| 4.2.3 | Indirect | Palm out | Standard operating procedure |
| 4.2.4 | Indirect | Sweep flashlight beam back-and-forth across the ground | Standard operating procedure when visibility is low |
| 4.3.2 | Indirect | Two whistle bursts | Standard operating procedure |
| 4.3.3 | Indirect | Motion to move with arm and point to directed location | Standard operating procedure |
| 4.3.4 | Indirect | Direct flashlight beam across ground in intended direction | Standard operating procedure when visibility is low |
| 4.4 | Indirect | Vehicle emergency lights and message boards | Standard operating procedure |

| | |
|---|---|
| **Direct:** | Physical interaction between a public safety officer and the subject vehicle |
| **Indirect:** | Communication via lights and sirens, maneuvering by positioning public safety vehicle for traffic control and access |
| **Informational:** | Public safety officer gathers information (e.g., electronically scans license plate to determine ownership) |

### 4.1.4 Lock-in/Lockout

An emergency vehicle lock-in/lockout encompasses situations that involve a fire or if there is some other threat to life or property and responders need to gain access to the vehicle. Some police departments conduct vehicle lock-in/lockout procedures as a general duty regardless of emergency (Rockville City Police Department, 2010); however, not all agencies do this because of potential liability issues (K. Weaver, personal communication, May 30, 2018); (Northampton Police Department, 1999).

Once on the scene of a locked vehicle, public safety authorities will need to determine if the situation is an emergency. Examples might include needing to free a child, animal, or person who may be having a medical issue and not able to exit the vehicle independently (Flint Hill Fire Department, 2013). Regardless of emergency, police may obtain a full description of the vehicle, including color, type, model, owner, and the type of lock on the vehicle (Rockville City Police Department, 2010). It is not clear if all agencies, including fire, universally obtain this

information when performing these procedures. If the lockout call is not an emergency, as a child trapped in a hot vehicle would be, police and fire personnel consider it a low priority call and warn that vehicles may be damaged while attempting to gain entry (City of Hilliard, 2018).

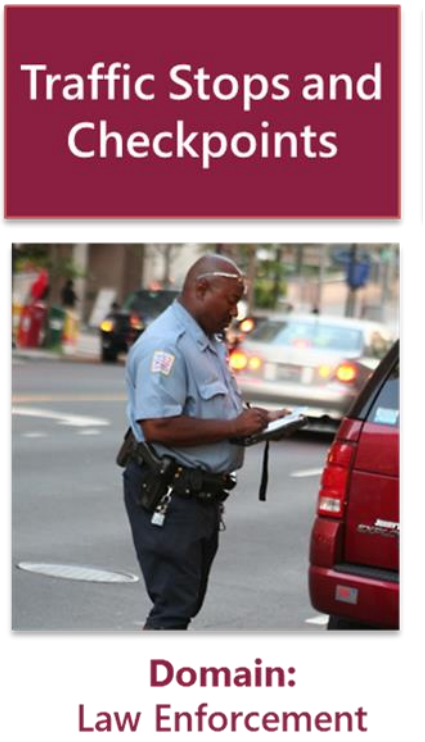
To open a locked vehicle there are a number of tools a public safety authority may use depending on their agency or department. In general, lockout kits include tools for prying open a window and a wedge to keep it open. Metal rods with hooks or loops are used to extend between the door and the bent glass to access the door lock (*The BigEasy,* 2015).

While a lock-in/lockout procedure is an obvious interaction between public safety authorities and conventional vehicles, the extent of the interaction is minimal and does not warrant an in-depth task description. Essentially, a public safety authority arrives on scene and uses tools to access the vehicle. The tools involved and the application of these tools may vary slightly depending on the type of door lock.

## 4.2 Law Enforcement

The most common form of direct contact between law enforcement personnel and drivers is a traffic stop. In 2011, approximately 42% of face-to-face contacts between law enforcement and U.S. residents were traffic stops. About 3% of those traffic stops resulted in a search of the driver, vehicle, or both (Office of Justice Programs, 2017). Traffic stops can be divided into low-risk or routine stops and high-risk or felony stops. Other types of interactions include law enforcement personnel assisting a stranded motorist or investigating an abandoned vehicle. Depending on jurisdiction and level of authority, law enforcement officers sometimes have the right to commandeer a vehicle, although these instances are rare. Other types of interactions include those of an indirect nature, such as responding to a call with lights and siren or managing traffic around an accident scene; these are interactions where law enforcement must communicate to other drivers. Police are also tasked with stopping vehicles at checkpoints or escorting vehicles as they would for a funeral procession.

### 4.2.1 Complete Traffic Stop




Routine traffic stops, which include those where police observe a violation and then request that drivers pull over, are the most common interactions police have with motorists (Gaines & Kappeler, 2010). A felony traffic stop is a stop where police request that a driver pull over because the driver is either known for or suspected of committing a felonious act that could be unattributed to driving. While each traffic stop presents risk to law enforcement, felony traffic stops are obviously considered high risk and require police to call for backup prior to requesting a pullover. Traffic enforcement leads to solving other crimes as well, such as recovery of stolen property, arrests for possession of drugs, and resolution of other non-driving-related crimes (Gaines & Kappeler, 2010).

#### *4.2.1.1 Overall Plan: Complete Traffic Stop*

The ultimate goal of this task, regardless of cause, is to convince a violating vehicle to pull over and stop so that law enforcement can approach the vehicle and interact with the driver or occupants.

#### *4.2.1.2 Subtask 1: Obtain Information*

Prior to a stop, police must have a reasonable suspicion or have directly observed conduct necessary for the stop (Florida Highway Patrol, 2015; LaFave, 2004); officers will take note of license number, location, and record a description of the vehicle (Florida Highway Patrol, 2015; Jackson, 2013; Murgado, 2012). Some agencies will also report the number of occupants they can see inside the vehicle to dispatch. Some agencies require that this information be transmitted through dispatch prior to officers activating their emergency lights and pulling the violator over (Lakewood.org, 2018; Murgado, 2012). One reason given for this is that once the vehicle stops

and a tactical situation unfolds, police do not have to interact with the radio to provide this information (Murgado, 2012). A second reason given is that if the information provided by the license plate informs police that the stop may lead to a felony arrest, due to warrants or prior offenses, then they would want to ensure backup is in the area before initiating the stop for personal safety (Figure 30).

**Figure 30. Example of an officer transmitting information to dispatch.**

Informational extractions include the reading of license plates. Technology—such as Automated License Plate Recognition—exists to make the task of relaying license plate information automatic. Law enforcement personnel use this technology when attempting to locate stolen or wanted vehicles; wanted suspects, witnesses, or victims; or at-risk missing persons (Roberts & Casanova, 2012). The technology is typically not permitted to collect data within public view or to monitor individual activities (San Jose Police, 2018). During periods of inclement weather, vehicle license plates may become obscured by compacted snow (see Appendix D, Item No. 45). Figure 31 illustrates the task flow for the operations leading from subtask 1 to subtasks 2 and 3.

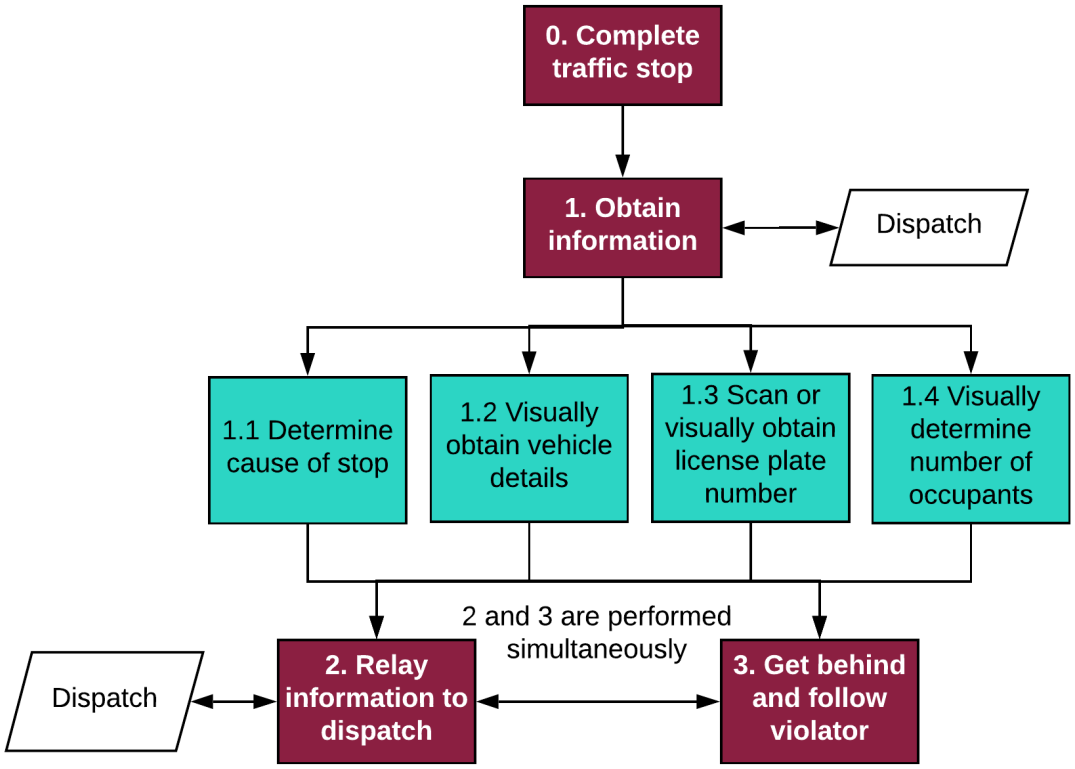



**Figure 31. Complete traffic stop subtask 1.**

#### *4.2.1.3 Subtask 2: Relay Information to Dispatch*

The information gathered in subtask 1 will be relayed to dispatch. If the stop is regarded as high-risk, which can be due to prior arrests, suspicion of previous crime, or the number of occupants in the vehicle, the officer may request backup. In general, if there appear to be at least three occupants, then a backup unit will be called (C. Carroll, personal communication, May 26, 2018). In the event the stop is a felony traffic stop—i.e., the violator is being stopped to carry out an arrest—backup is required in most jurisdictions (International Association of Chiefs of Police, 2004; Jackson, 2013; San Jose Police, 2018). Subtask 2 and subtask 3 are conducted simultaneously.

#### *4.2.1.4 Subtask 3: Get Behind and Follow Violator*

During a pullover of any type, police close the distance on the violator's vehicle and engage their emergency lighting (International Association of Chiefs of Police, 2004; Lakewood.org, 2018; San Antonio Police Department, 2015). In the process of doing so, other vehicles are encouraged to pull over or change lanes to yield to police (North Carolina Division of Motor Vehicles, 2016;

Virginia Department of Motor Vehicles, 2017). According to Washtenaw County Michigan Sheriff's deputy Jeff Gotarski, police will wait to engage their lights until they are directly behind their target vehicle, as engaging them too soon could allow the motorist to perform evasive maneuvers before the police get close (personal communication, May 29, 2018). However, in situations where police must drive in excess of the posted speed limit, they will initiate their lights to alert other motorists (Florida Highway Patrol, 2015).


**Figure 32. Example of a law enforcement official trailing a violating vehicle.**

Police will trail the violating vehicle prior to initiating a stop through the use of lights and/or sirens in an attempt to determine a safe location for the vehicles to pull to the side of the roadway (Figure 32). Officers try to avoid initiating stops where they think a violator may try to stop in an area with a short range of visibility, such as on a hillcrest or in a curve. Areas such as exit ramps and areas where vehicles merge are also avoided. Sections of narrow roadway or areas with no shoulder will also be avoided. Police also try to avoid stopping vehicles in business lots or private lots, although sometimes this is necessary if no other safe location is available. When conducting a stop, police may avoid areas that impact their personal safety, such as near bars, high crime areas, or areas with several bystanders or pedestrians. When stopping larger vehicles, several of these factors are exacerbated as finding a suitable location for a large vehicle to stop and be completely out of the roadway can be a challenge (see Appendix D, Item No. 46).

In some cases of extreme inclement weather or an officer's lack of confidence that a stop can be conducted safely, they may avoid initiating a stop altogether. The lack of a shoulder to conduct a stop on a narrow roadway or the presence of snowbanks may prevent a stop from occurring at all. Additionally, in inclement weather, police may reduce stops to prevent secondary crashes that result from vehicles merging lanes to either make way for police or when observing the law to merge for a stopped emergency vehicle (see Appendix D, Item No. 47). A lack of experience or confidence in interacting with larger vehicles, such as tractor trailers, may result in fewer

stops by law enforcement as drivers of larger vehicles have a tactical advantage over police. In some cases, law enforcement may request the driver of a tractor trailer to step out or shut off their engine if it is loud (see Appendix D, Item No. 48).

Once police follow a violator's vehicle and initiate their lights, they expect that vehicle to immediately signal to pull over at the next opportunity (San Antonio Police Department, 2015). If a vehicle does not pull over right away, police may then turn on their sirens in an extra attempt to get the driver's attention (Lakewood.org, 2018). If a vehicle refuses to pull over, a pursuit may ensue (J. Gotarski, personal communication, May 29, 2018). For larger vehicles, police may need to veer into the adjacent lane so they become visible in the driver's mirrors (see Appendix D, Item No. 49). Certain types of police vehicles, such as SUVs or unmarked vehicles, are recognized less as police vehicles and may not be used for traffic stops depending on the jurisdiction (see Appendix D, Item No. 50).

Prior to a pursuit, police must attempt to stop a driver lawfully by using lights and sirens while following. A decision to pursue the violator is made when the violator increases speed and attempts to flee the officer, or after the violator should reasonably know that they are being asked to stop (International Association of Chiefs of Police, 2004). If the violator is believed to be a felon who poses a significant and ongoing threat to public safety, then a pursuit may also be warranted. Pursuit policies differ from agency to agency; however, in most cases the decision to initiate a pursuit is left to the discretion of the officer (Nugent, Connors, McEwen, & Mayo, 1990). During the pre-pursuit phase, officers attempt to gather as much information as possible about the number of occupants, the vehicle, the suspected offenses, and the surrounding environment. Pursuit is contingent on many factors, including whether backup is available, how familiar an officer is with their surroundings, time of day and road conditions, and/or whether hostages are inside the vehicle (California POST, 2007). Similar to when responding to an accident or attempting a routine pullover, police engage lights and sirens with the expectation that nearby traffic will yield the right-of-way.

**Figure 33. Example of a traffic stop.**

Once a vehicle stops (Figure 33), the officer will take note of the location and judge whether or not it is acceptable as a stopping location (Jackson, 2013; Stradling, 2018). In general, drivers are instructed through driving manuals to stop in a location that is safe and does not affect the flow of traffic (Lamboy, 2012; Virginia Department of Motor Vehicles, 2017). Drivers are instructed to turn on their flashers as well as turn down their radio or anything that would block communication with an officer (Virginia Department of Motor Vehicles, 2017). If there is no safe place to pull over, drivers should turn on their flashers and slow by approximately 10 mph to convey to the officer that they plan to pull over (Stradling, 2018). Police will ensure that vehicles are not in the flow of traffic and give attention to their surroundings, taking note of such elements as intersections, alleyways, terrain, and lighting (Lakewood.org, 2018; Murgado, 2012). If a vehicle pulls over in an area considered hazardous, police may use their vehicle's public address system to communicate to the driver where to move the vehicle (Florida Highway Patrol, 2015) or approach the vehicle and instruct the driver where to move (C. Carroll, personal communication, May 26, 2018). Drivers are encouraged to place their vehicles in park and turn off their engine but to leave their seatbelts on and keep their hands on the steering wheel and in plain view (Stradling, 2018).

Subtask 2 and subtask 3, which address following violators, are diagrammed in Figure 34. Between relaying information to dispatch and navigating to get behind a violator's vehicle, there are no direct or informational interactions, only indirect. These indirect interactions include maneuvering through traffic with lights, and potentially the siren, engaged to communicate to the violating vehicle as well as surrounding traffic that a law enforcement procedure is underway.

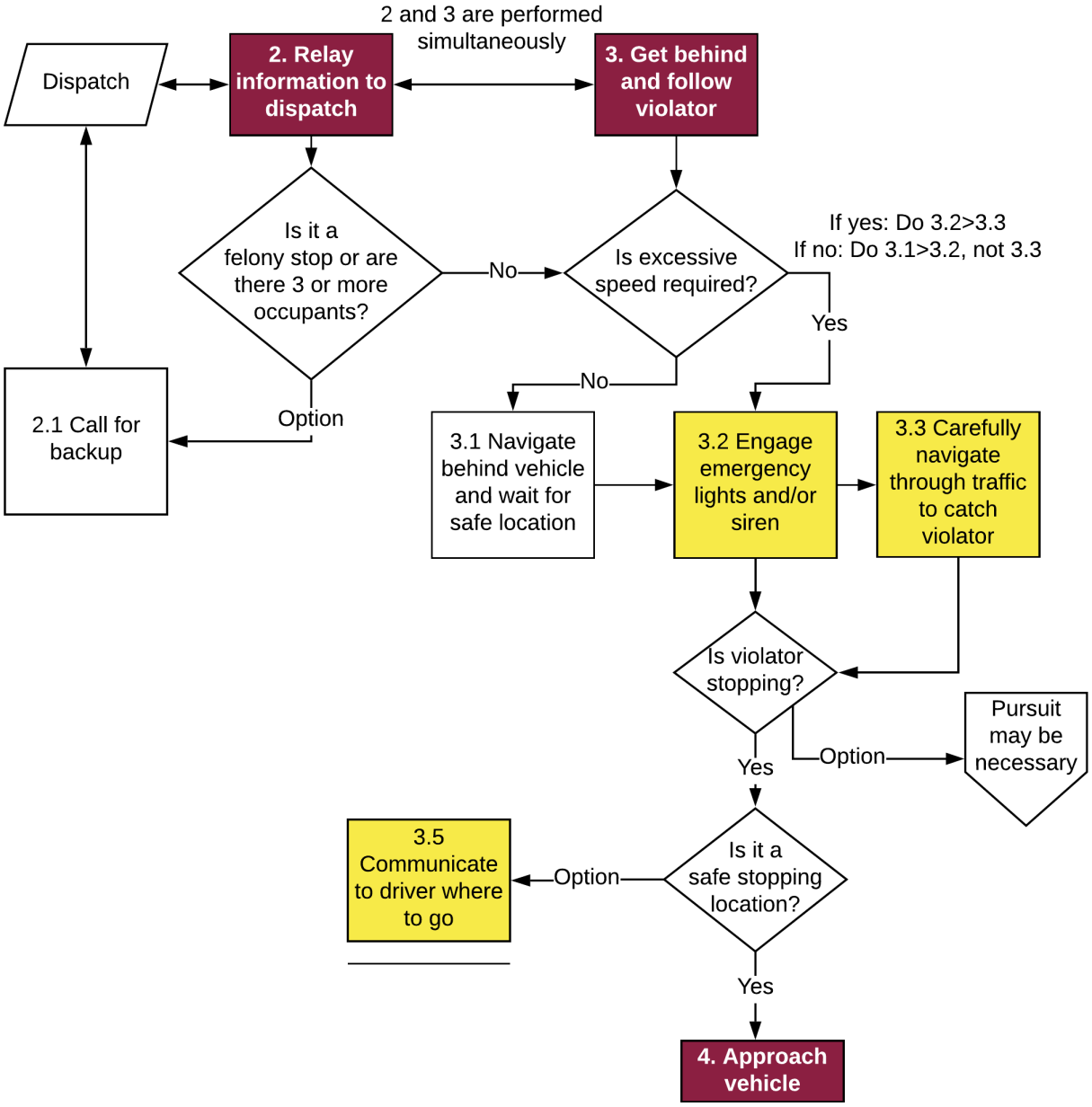



**Figure 34. Complete traffic stop subtasks 2 and 3.**

*4.2.1.5 Subtask 4: Approach Vehicle*

Once the vehicle pulls over, police pull within 10 feet of the violator's vehicle and off-center from the violator's vehicle by a half-length to the left (closer to the lane of travel, if possible) (International Association of Chiefs of Police, 2004; Lakewood.org, 2018; San Jose Police, 2018; Texas Education Agency, 2011). At night, police shine their spotlight on the side or rearview mirror of the violating vehicle (Jackson, 2013). Drivers are encouraged to turn on their

interior or dome light at night (Lamboy, 2012). The use of a spotlight restricts the driver's vision of the approaching officer and also allows the officer to see the eyes and hands of the person in the driver's seat (Jackson, 2013; Texas Education Agency, 2011). Police attention is focused on either the hands or eyes of the driver as they approach the vehicle (Texas Education Agency, 2011). During the day, the vehicle's interior and the driver are more visible, and a spotlight is not necessary. Some state driver's manuals have been updated to include a warning that at night police will likely use a spotlight on a violator's vehicle and that turning on an interior light can help law enforcement (Stradling, 2018).

Police leave their lighting systems activated for the duration of a stop to warn passing motorists of the stop. All 50 U.S. states and each Canadian province have "Move Over Laws" that require motorists to merge away from vehicles with active warning lights, including law enforcement, firefighters, EMS, utility workers, and sometimes tow-truck operators. The laws vary slightly between states and provinces, as some require specific speed reductions and stipulate the types of public safety vehicles that the law applies to. Washington, DC, does not have a move over law (American Automobile Association, 2018).


**Figure 35. Law enforcement officials approaching a stopped vehicle and touching the trunk to establish contact.**

Depending on jurisdiction and training, police are often instructed to check the trunk or rear hatch of a vehicle by pressing on it with their hands as they move toward the driver (Florida Highway Patrol, 2015; Lakewood.org, 2018; Texas Education Agency, 2011). Some agencies instruct officers to press on the trunk or rear hatch as well as the taillight all at once (C. Carroll, personal communication, May 26, 2018; Figure 35). This is done to ensure that an ambush from these areas of the vehicle will not occur and also to leave a fingerprint on the violating vehicle for proof of an interaction (Texas Education Agency, 2011). Also on the approach, police carefully observe the occupants inside the vehicle for any suspicious behavior (Lakewood.org, 2018), which includes watching

their eyes reflected in the side and rear mirrors as well as their hands (C. Carroll, personal communication, May 26, 2018).

Depending on jurisdiction, training, or roadway, police may approach a vehicle from either the driver's side or passenger's side window, although the driver's side is the most common (Jackson, 2013). Police expect the driver's window to be completely down (Lamboy, 2012); drivers are sometimes instructed to do this via driving manuals (Virginia Department of Motor Vehicles, 2017). If the window is not already down, police may lightly knock on the window to get the occupant's attention (C. Carroll, personal communication, May 26, 2018). After knocking on the window, police will step back from the vehicle in the event the occupant is startled or attempts to open their door, which could knock the officer into traffic (C. Carroll, personal communication, May 26, 2018). If a driver continues to refuse to open their window, the police may resort to smashing a window of the vehicle to gain access (C. Carroll, personal communication, May 26, 2018). Police are encouraged to stand toward the rear of a driver's window so that if a door is opened, the officer will not be pushed into the roadway or struck by the door (Figure 36). This also allows the officer to assume an advantageous physical position, as the driver needs to turn to interact (Lakewood.org, 2018). Furthermore, police are trained to not reach inside the vehicle even during an exchange of documentation with the driver (Jackson, 2013). If a driver's windows are tinted, police may ask the driver to roll down the windows so police can see inside the vehicle more easily (see Appendix D, Item No. 51).

**Figure 36. Example of a police officer standing to the rear of the driver's window.**

If police are unable to view the number of passengers inside a vehicle, perhaps due to the vehicle's size and shape or tinted windows, police may verbally request the driver to tell them the number of occupants inside the vehicle prior to approaching it. Additionally, prior to a traffic stop, police may drive beside a vehicle to peer inside and visually determine the number and positioning of occupants (see Appendix D, Item No. 52).

Figure 37 shows the diagram for subtask 4, where approaching a violator's vehicle can consist of direct, indirect, and informational interactions.

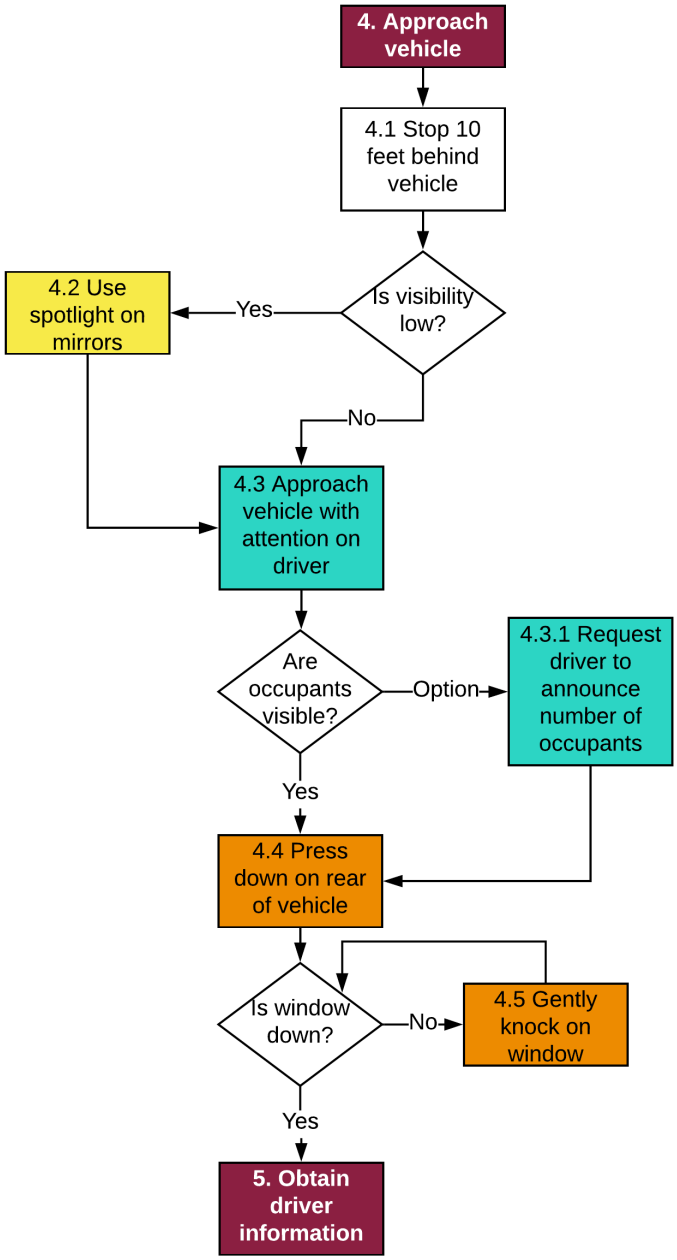



**Figure 37. Complete traffic stop subtask 4.**

#### *4.2.1.6 Subtask 5: Obtain Driver Information*

There are a number of potential verbal exchanges that take place at this time but, in general, the next task for police is to ask for the driver's license, the vehicle's registration documentation, and/or proof of insurance (Jackson, 2013; Texas Education Agency, 2011; Virginia Department of Motor Vehicles, 2017). Proof of insurance may not be requested at each traffic stop; rather, it is usually only requested if a crash has occurred (C. Carroll, personal communication, May 26, 2018). Once this information is provided, police will either stand away from the violator's vehicle or walk back to their (police) vehicle (Jackson, 2013). This is so they do not need to attend to the occupant while they review the documentation (Figure 38). Police are instructed to keep their attention on oncoming motorists as well as the violator's vehicle as they walk back to their vehicle (Jackson, 2013; Texas Education Agency, 2011).

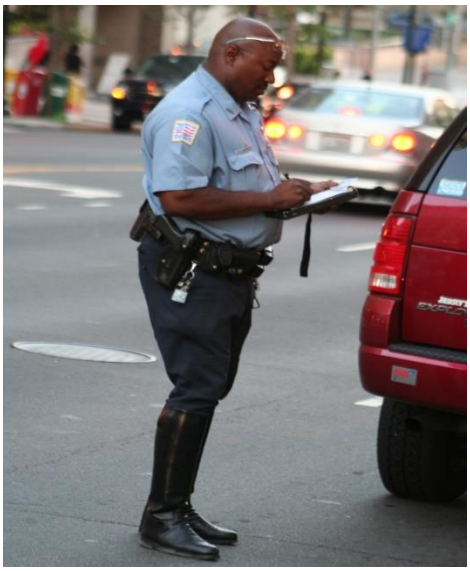


**Figure 38. Example of an officer issuing a citation.**

If documentation cannot be provided, subsequent actions may be required depending on police discretion or situational factors. Police may ask the driver or all occupants to step out of the vehicle. Ultimately, failure to provide sufficient documentation, such as proof of insurance, licensure, or registration, can result in the vehicle's impoundment (San Antonio Police Department, 2015). If a driver does not have a license or fails to produce satisfactory proof of a valid license, an officer has probable cause to arrest that individual for a violation (Cincinnati Police, 2014; Jackson, 2013). To supplement licensure, drivers may provide officers with a name and date of birth or social security number, which the officer will check against a database to determine if there is any evidence of an invalid licensure (Cincinnati Police, 2014). If a driver does not have a valid driver's license but does have evidence of financial responsibility for the vehicle there are different options depending on locality. For example, a general manual for traffic law enforcement in the city of San Antonio states that in instances such as these, a passenger in the vehicle with a valid driver's license may remove the vehicle, the driver may be allowed 30 minutes to contact someone with a valid driver's license to remove the vehicle, or if the vehicle cannot be removed by someone with a

valid driver's license within that span of time, then the vehicle will be impounded (San Antonio Police Department, 2015).

Police will then return to their vehicle to process a citation or warning using the information provided by the driver (Texas Education Agency, 2011). Once the citation is written, police return to the same window of the violator's vehicle, explain the citation, and request a signature (International Association of Chiefs of Police, 2004; Jackson, 2013). Refusal to sign a citation can result in arrest or the vehicle being impounded (San Antonio Police Department, 2015) although, not all states require a citation signature after a stop. After signatures are obtained, police may wait in their vehicle for the violator's vehicle to pull away to ensure they are not struck as they merge back onto the roadway (C. Carroll, personal communication, May 26, 2018). In some cases, police may pull onto the roadway first with emergency lights engaged to act as a buffer for the violating vehicle to reenter the roadway (see Appendix D, Item No. 53). Figure 39 illustrates the procedures for subtasks 5, 6, and 7. Subtask 5 for obtaining driver information is made up of only informational interactions, which is to be expected. There are no interactions in subtask 6. Subtask 7 is comprised of two more interactions: receiving a signature and remaining parked on the shoulder with emergency lights engaged to influence traffic to slow down and merge while the violator's vehicle attempts to reenter the roadway.

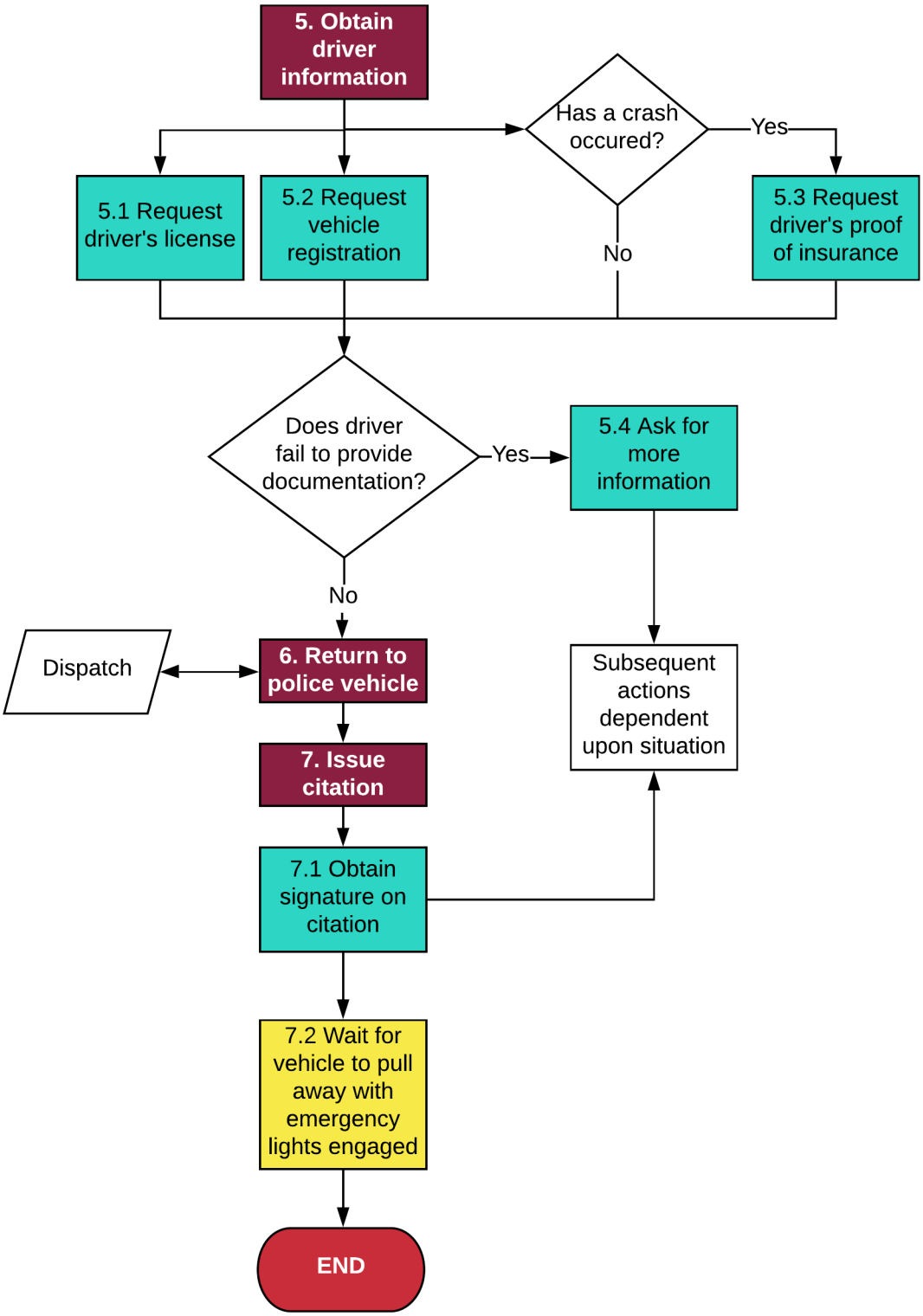



**Figure 39. Complete traffic stop subtasks 5, 6, and 7.**

Table 9 details the types of interactions, their descriptions, and any contingencies to initiating the interactions for routine and felony traffic stops.

**Table 9. Interaction Types, Descriptions, and Contingencies for Complete Traffic Stop Subtasks**

| Task | Interaction Type | Interaction Description | Contingency or Standard Procedure |
|---|---|---|---|
| 1.1 | Informational | Determine cause of traffic stop | Standard operating procedure |
| 1.2 | Informational | Visually obtain vehicle details | Standard operating procedure |
| 1.3 | Informational | Electronically scan or visibly obtain license plate number | Standard operating procedure |
| 1.4 | Informational | Visually determine number of occupants | Standard operating procedure |
| 3.2 | Indirect | Engage emergency lights and/or siren | If navigating through traffic at excessive speed or behind violator |
| 3.3 | Indirect | Navigate through traffic to catch violator | If not directly behind violating vehicle |
| 3.4 | Indirect | Engage emergency siren | If violator does not indicate slowing down or stopping within a few seconds |
| 3.5 | Indirect | Use public address system to communicate to driver | If violator does not stop in a safe area |
| 4.2 | Direct | Use spotlight on mirrors | If visibility is low |
| 4.3 | Informational | Visually attend to driver's hands and eyes | Standard operating procedure |
| 4.3.1 | Informational | Verbally request driver to announce number of occupants | If number of occupants not apparent or visible |
| 4.4 | Direct | Press down on trunk | Standard operating procedure |
| 4.5 | Direct | Gently knock on window | If window not already down |
| 5.1 | Informational | Request driver's license | Standard operating procedure |
| 5.2 | Informational | Request vehicle registration | Standard operating procedure |
| 5.3 | Informational | Request driver's proof of insurance | Standard operating procedure |
| 5.4 | Informational | Ask for more information | If driver fails to provide requested documentation |
| 7.1 | Informational | Obtain signature on citation | Standard operating procedure |
| 7.2 | Indirect | Wait for vehicle to pull away | Standard operating procedure |

**Direct:** Physical interaction between a public safety officer and the subject vehicle
**Indirect:** Communication via lights and sirens, maneuvering by positioning public safety vehicle for traffic control and access
**Informational:** Public safety officer gathers information (e.g., electronically scans license plate to determine ownership)

### 4.2.2 Assist Motorist

The specific types of assistance a law enforcement officer can provide a motorist in need are dictated by the department (International Association of Chiefs of Police, 2004). In most cases, if an officer can provide assistance, they are expected to do so (Northampton Police Department, 1999). However, in the event that assistance cannot be provided, the police will assist the motorist by requesting a towing agency. The types of assistance typically provided by police include changing flat tires, addressing lock-ins/lockouts, providing gasoline, jump-starting vehicles, providing traffic control, or notifying family members of the motorist's situation

(Northampton Police Department, 1999; Virginia State Police, 2010). Some departments have policies against police pushing, pulling, towing, or jump-starting any vehicle with their police vehicle (Northampton Police Department, 1999). If a motorist is stranded on a highway, in a hazardous location, or in inclement weather, officers are encouraged to stay with the motorist with their emergency lights active to warn approaching traffic and encourage them to merge away (International Association of Chiefs of Police, 2004).

#### *4.2.2.1 Overall Plan: Assist Motorist*

The goal of this task is to assist a motorist by actively assisting with repairs, calling a tow agency, or waiting for someone to provide aid.

#### *4.2.2.2 Subtask 1: Gather Information*

Law enforcement learn of disabled vehicles and stranded motorists in two main ways: happening upon them while on patrol, or receiving a report via dispatch (Northampton Police Department, 1999). The latter requires police to navigate to the location of the motorist, which is not usually considered an emergency unless the disabled vehicle is in a hazardous location. When police arrive at the disabled vehicle, they pull in behind the vehicle in a manner similar to a traffic stop and engage their emergency lights. The lights are to encourage passing motorists to slow down and merge if possible. If the vehicle is disabled in a hazardous location, such as in a lane, police secure the scene as they would for a crash or incident as described in section 4.1.2 Secure a Scene (Northampton Police Department, 1999). Some agencies, such as the Florida Highway Patrol, are not permitted to block the lane of a disabled vehicle except to temporarily place flares or other warning devices (Florida Highway Patrol, 2015).

Figure 40 illustrates the tasks and interactions associated with subtask 1 to gather information about a disabled vehicle. The only interaction in this phase of the operation is engagement of emergency lights to signal to surrounding traffic that a police vehicle is parked on the shoulder.

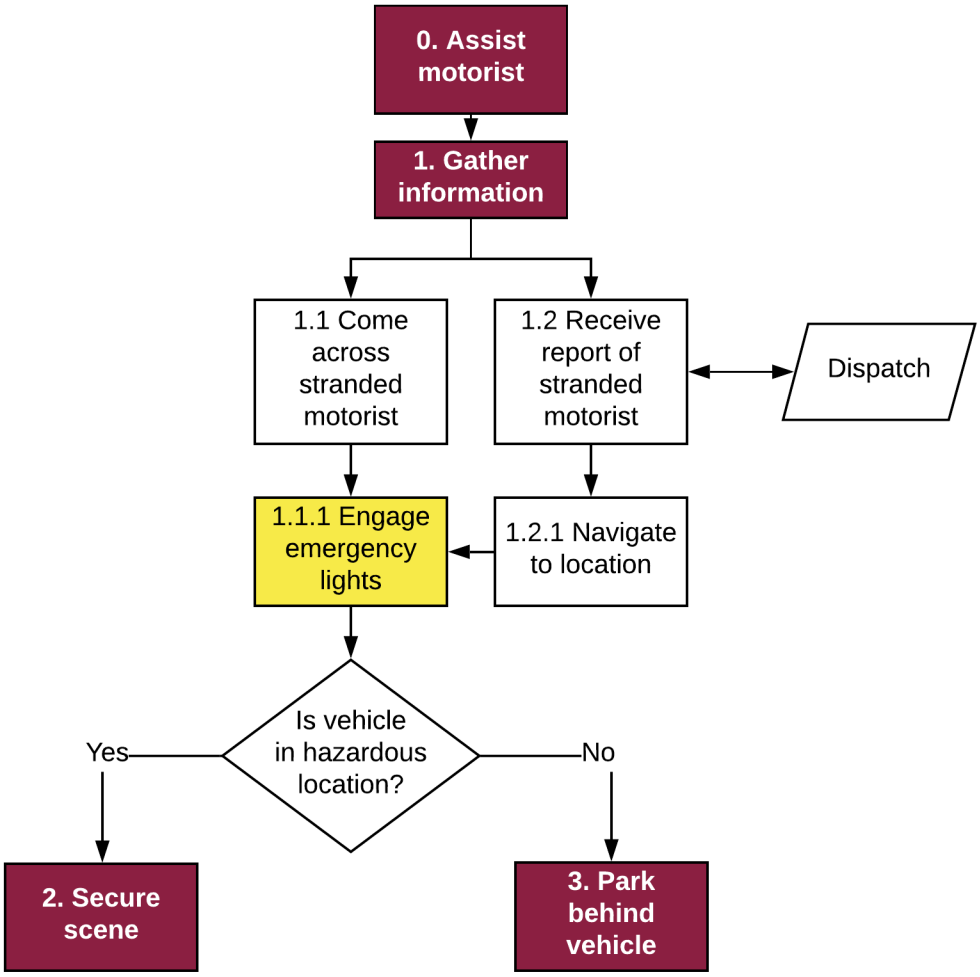



**Figure 40. Assist motorist subtask 1.**

*4.2.2.3 Subtask 2: Secure Scene & Subtask 3: Park behind Vehicle*

Depending on circumstances, police may have to secure the scene by blocking a lane of traffic with their vehicle. This may occur if the motorist is stranded in a lane of travel or a location hazardous to other traffic. To secure a scene, the officer will position their vehicle in the same lane as the disabled vehicle to maximize the amount of the police vehicle that approaching traffic can see. The distance that the police park behind the disabled vehicle is dictated by the road type and road geometry. Police will try to position their vehicle before a curve or crest to ensure that approaching traffic can recognize the hazard in enough time (C. Carroll, personal communication, May 26, 2018).

Similar to a traffic stop, if possible, police will pull behind and to the left of a disabled vehicle with half the width of the front of their vehicle overlapping the other vehicle (C. Carroll, personal communication, May 26, 2018).

#### *4.2.2.4 Subtask 4: Obtain Information*

Prior to approaching the vehicle, police make a cursory visual assessment of the situation and relay that information to dispatch. The types of information include: 1) details of the vehicle, including color, make, and model; 2) the license plate number, and 3) number of occupants. The police may also speculate on the motorist's issue based on information visually available. For example, if the vehicle has a visible flat or the driver has opened the hood of the vehicle would suggest two different types of assistance (C. Carroll, personal communication, May 26, 2018).

The subtasks of securing a scene or parking behind the disabled vehicle and obtaining information on the disabled vehicle are diagrammed in Figure 41. The primary interactions of subtask 2 are indirect interactions with other traffic as the law enforcement officer intends to position their vehicle in a way that is visible and communicates to other traffic to merge or be cautious. During subtask 4, the officer must obtain information about the vehicle, mostly visually.

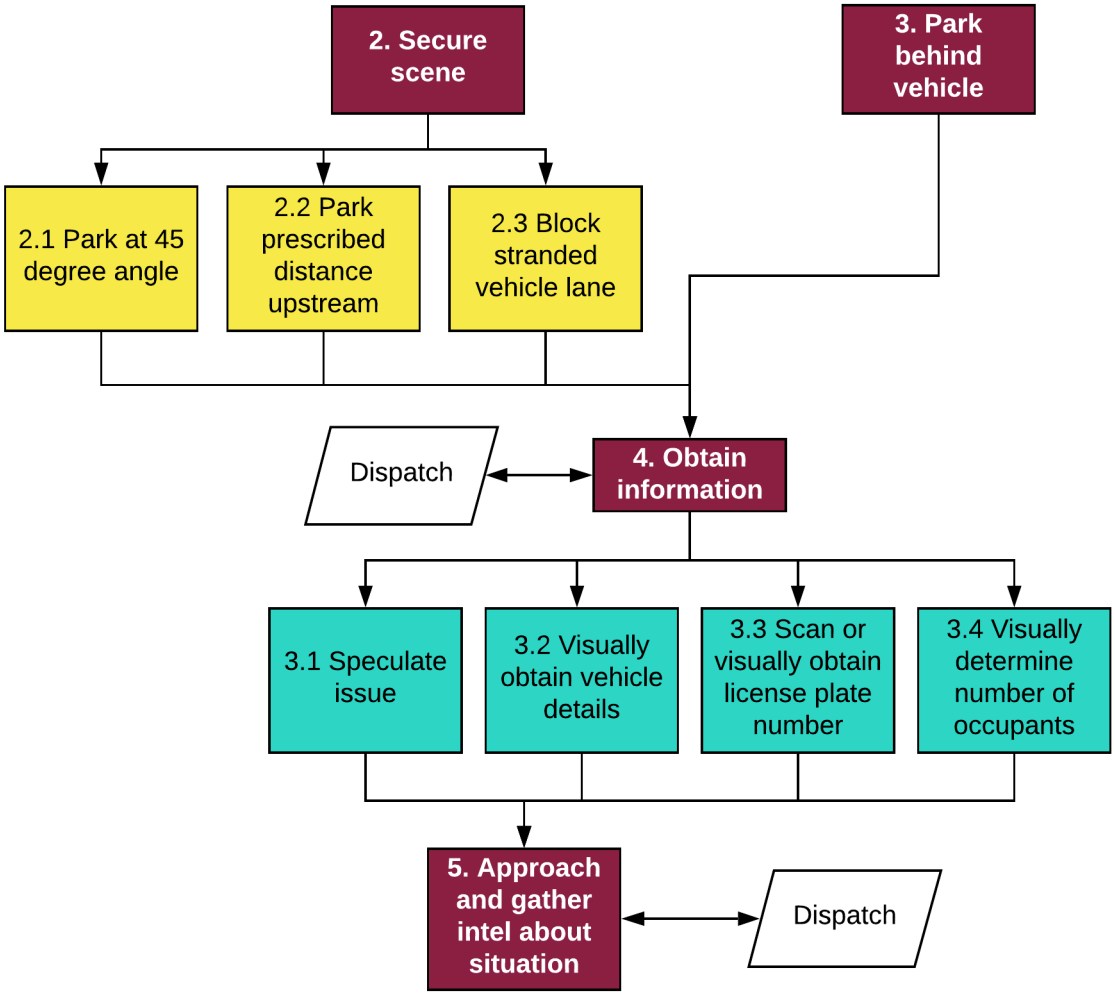



**Figure 41. Assist motorist subtasks 2, 3, and 4.**

*4.2.2.5 Subtask 5: Approach and Gather Information about Situation & Subtask 6: Provide Assistance*

When approaching the disabled vehicle, similar to a traffic stop, police will be on alert in the event the situation is not what it seems. The next task is to confer with the motorist about the problem and determine whether help can be provided. If the police officer possesses the skills and permission to adequately assist the motorist to clear the scene, they may elect to do so if the task can be completed in a timely and efficient manner. Otherwise, the officer will continue to block the scene while either a tow is arranged or the motorist finds someone on their own to address the issue quickly and efficiently. The amount of time provided to motorists to arrange their own assistance is left to the discretion of the police officer. If the amount of time is

considered excessive, the police officer may arrange a tow through dispatch. In either case, police will remain on scene until the vehicle is cleared (Northampton Police Department, 1999).

If a vehicle is not immobilized and can be moved out of a hazardous location, police may order the driver to do so (K. Weaver, personal communication, May 30, 2018).

Subtask 5 consists of only a single highlighted interaction where police observe the vehicle issue, which may involve witnessing smoke from the vehicle or noticing a flat tire. Subtask 6 involves various direct interactions, which could include fixing a flat, providing a jumpstart, or pushing the vehicle (Figure 42).

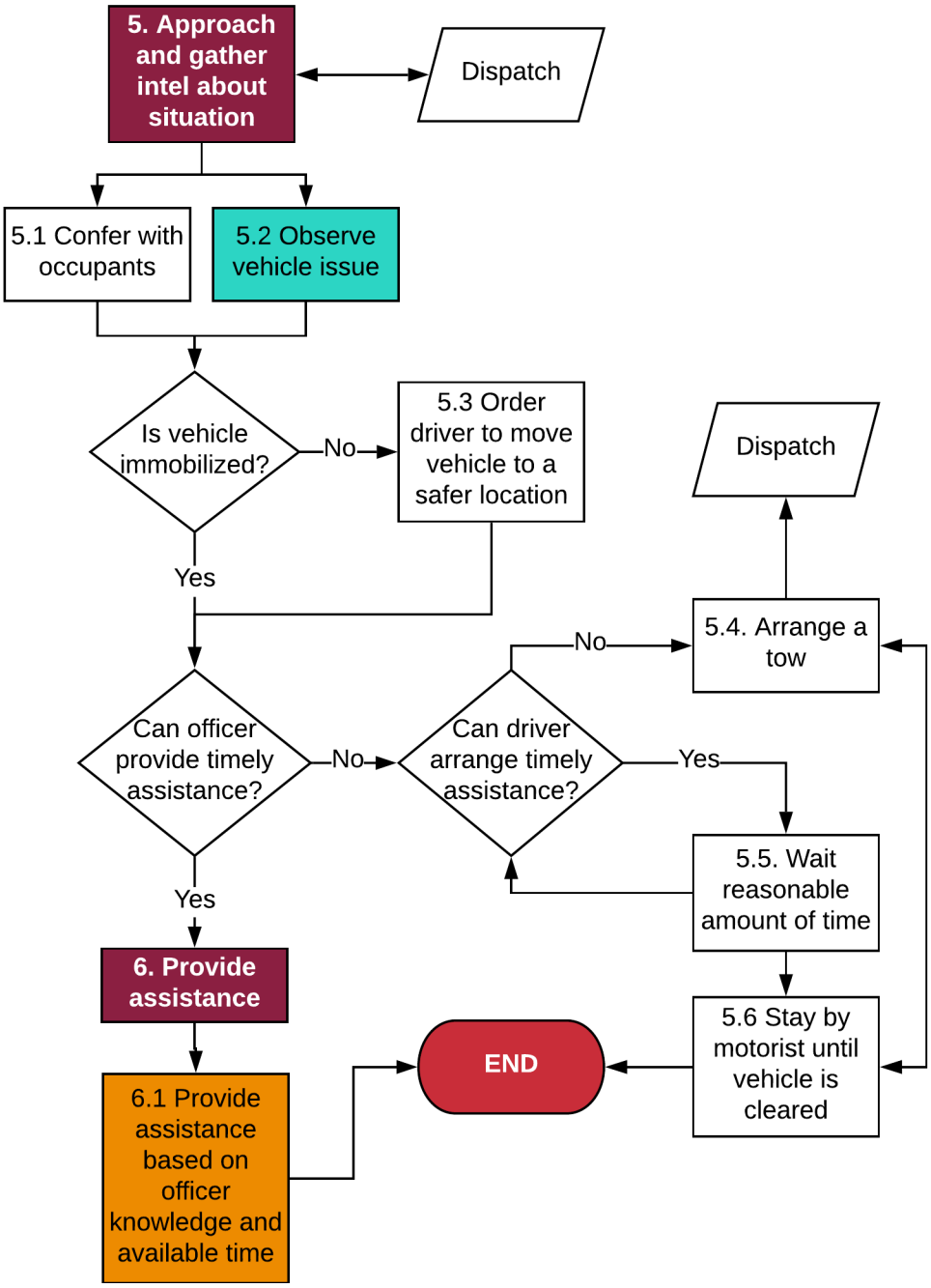



**Figure 42. Assist motorist subtasks 5 and 6.**

Table 10 details the interactions throughout the motorist assist operation. In summary, most of these interactions are part of standard operating procedure for most agencies and consist mainly of indirect and informational interactions. A direct interaction may occur if an issue with the disabled vehicle can be addressed in a timely manner by the officer on site.

**Table 10. Interaction Descriptions for Assist Motorist Subtask**

| Task | Interaction Type | Interaction Description | Contingency or Standard Procedure |
|---|---|---|---|
| 1.1.1 | Indirect | Engage lights to alert nearby motorists | Standard operating procedure |
| 2.1 | Indirect | Park at 45-degree angle | Standard operating procedure |
| 2.2 | Indirect | Park prescribed distance upstream | Standard operating procedure |
| 2.3 | Indirect | Block stranded vehicle lane | Standard operating procedure |
| 3.1 | Informational | Speculate issue | Standard operating procedure |
| 3.2 | Informational | Visually obtain vehicle details | Standard operating procedure |
| 3.3 | Informational | Scan or visually obtain license plate number | Standard operating procedure |
| 3.4 | Informational | Visually determine number of occupants | Standard operating procedure |
| 5.2 | Informational | Observe vehicle issue | Standard operating procedure |
| 6.1 | Direct | Provide assistance | If officer ability and time allow |

**Direct:** Physical interaction between a public safety officer and the subject vehicle
**Indirect:** Communication via lights and sirens, maneuvering by positioning public safety vehicle for traffic control and access
**Informational:** Public safety officer gathers information (e.g., electronically scans license plate to determine ownership)

### 4.2.3 Address Abandoned Vehicles


A vehicle is generally considered abandoned if it is left on public property for more than 48 hours; however, state laws and local ordinances may change the amount of time a vehicle can be left unattended. For example, some cities specify that a vehicle left unattended on a city street for 72 hours is considered abandoned (Northampton Police Department, 1999; San Jose Police, 2018). Some jurisdictions, such as the Montgomery County Sherriff's Office in Virginia, consider a vehicle abandoned after only 24 hours, but attempt several methods for contacting the registered owner of the vehicle prior to requesting a tow (K. Weaver, personal communication, May 30, 2018). There are some jurisdictions where any abandoned vehicle can be towed immediately and no time limit is specified. In other areas this may only be true for highways and interstates where vehicles may be left abandoned (see Appendix D, Item No. 54). A vehicle can be considered abandoned if left on private property for more than 48 hours without the consent of the property owner. In some states, vehicles are considered abandoned after being left unattended for 2 hours on a highway and must be removed within 24 hours or less of

receiving an abandoned tag (Missouri Department of Revenue, 2011; Utah Department of Public Safety, 2018). Any vehicle left unattended on the shoulder of a primary highway is considered abandoned in some states, such as Virginia (Virginia.gov, 2011). Even though it is customary for drivers to place a towel, shirt, or hang some item from a window of a vehicle to indicate to police that they will return for it, generally police treat the vehicles the same as those without those indications (C. Carroll, personal communication, May 26, 2018).

An unattended vehicle is one that may still powered or "running" but without a driver or occupants inside. Vehicles are often left briefly unattended in front of businesses or areas where the driver intends to return quickly. Like an abandoned vehicle, police will not need to interact with an unattended vehicle unless it is parked inappropriately or creating a hazard. Unlike abandoned vehicles, the procedures of dealing with an unattended vehicle are highly variable as there are no time limits or regulations regarding those vehicles aside from any posted parking restrictions. An unattended vehicle can become labeled as abandoned if no one returns for the vehicle after some discretionary time. If hazard lights are on or the vehicle is parked in an inappropriate or suspicious manner, police may investigate the vehicle to verify the individuals responsible for the vehicle are not experiencing trouble (see Appendix D, Item No. 55). If a vehicle only appears briefly unattended and not abandoned on a roadway, police may ignore it or wait a brief period for the occupants to return (see Appendix D, Item No. 56).

#### *4.2.3.1 Overall Plan: Address Abandoned Vehicle*

The goal of this task is to verify that a vehicle is abandoned and ensure that it is removed in a timely manner, which may require a search for the driver or a phone call to the last registered owner.

#### *4.2.3.2 Subtask 1. Determine Location*

Police determine the location of an abandoned vehicle either by driving by and noticing the vehicle themselves or by receiving a complaint from the public or a call about the abandoned vehicle. Once at the location of the abandoned vehicle, police must note whether the vehicle is in a hazardous location and determine if it poses an imminent threat to other traffic. If the vehicle is too close to the lane of travel or is blocking a fire lane, it may be necessary for police to act immediately. Depending on how the vehicle is positioned, police may secure a scene with flares

to alert traffic to the presence of the vehicle and call in a tow to have the vehicle removed (C. Carroll, personal communication, May 26, 2018).

If the vehicle is not in a hazardous location, police must determine if the vehicle has been there long enough to warrant an abandoned tag. It is protocol in many states for police to place a visible tag on a vehicle or mark the tires with chalk to signify that it has been seen by public authorities, typically with a time and date associated (K. Weaver, personal communication, May 30, 2018; Figure 43). If the vehicle has not been there for the required amount of time, police must wait before any action is taken. During periods of inclement weather, police may place the abandoned tag in a clear plastic bag that is attached to the vehicle or use spray paint in lieu of chalk (see Appendix D, Item No. 57). All abandoned vehicles are also logged electronically so that in the event they are towed, they are not labeled as stolen if an owner comes back to retrieve the vehicle (see Appendix D, Item No. 58).


**Figure 43. Abandoned vehicle tag.**

If a vehicle is on private property it typically requires the property owner to call and complain about the vehicle before law enforcement will take action. Some exceptions may exist. For example, police may patrol private business lots after hours and inspect suspicious vehicles that may be abandoned. Suspicious areas may include dead end roads, cul-de-sacs, near abandoned buildings, or near schools after hours. These factors depend on local laws and officer discretion in many cases (see Appendix D, Item No. 59). A vehicle parked in a fire lane does not always necessitate an immediate tow and typically requires the owner of the property to report the vehicle (see Appendix D, Item No. 60).

Regardless of time limits, vehicles may be towed immediately if their registration is out of date (see Appendix D, Item No. 61) or if they are parked in a hazardous area such as the apex of a

curve, on the crest of a hill, or somewhere that is impeding the flow of traffic. Inclement weather may also result in a vehicle being towed sooner, especially if it causes a hazard for other traffic or is parked on the shoulder during a period of snow that would prevent snowplows from operating. Police may not investigate an abandoned vehicle during inclement weather if it poses no immediate hazard to passing traffic (see Appendix D, Item No. 62).

Certain areas have no parking zones for certain periods that may necessitate an immediate tow. Parking zones can change seasonally or yearly but are denoted with signs (see Appendix D, Item No. 63). Toll roads often have different policies regarding abandoned vehicles; however, no specific differences were mentioned in the interviews. Additionally, many ordinances specify no street parking when snow reaches at least 2 inches deep (see Appendix D, Item No. 64).

#### *4.2.3.3 Subtask 2: Stop Behind Vehicle*

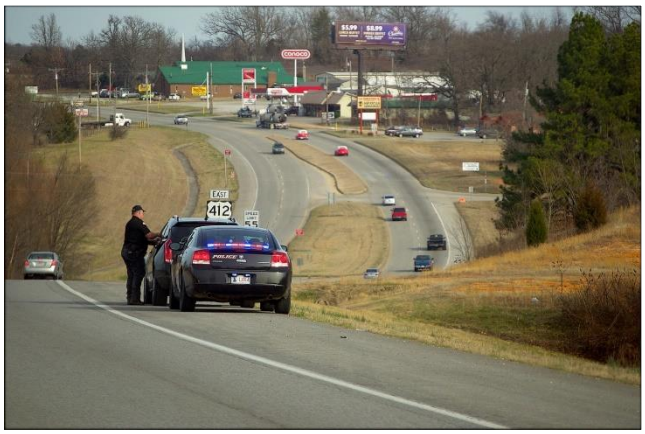



**Figure 44. Example of an officer stopped behind an abandoned vehicle.**

If the vehicle is considered abandoned, most police will park behind the vehicle with their lights engaged (Figure 44). The primary reason for the lights is to alert nearby motorists that a police vehicle has stopped in operation, although not all police will use their lights for this operation (see Appendix D, Item No. 65). Drivers in states with "Move Over Laws" are encouraged to merge away from the parked police vehicle if they are able to, particularly on high-speed highways and interstates (Carrick & Washburn, 2012). If a vehicle is abandoned or parked in an area with low visibility, such as on a hillcrest, in a curve, or obscured by foliage or overpasses, police may request that a backup officer park further upstream with lights engaged to serve as an advanced warning while the abandoned vehicle is inspected (see Appendix D, Item No. 66).

Both subtask 1 and subtask 2 are shown in Figure 45. Upon determining the location of an abandoned vehicle, no notable interaction occurs. It is not until subtask 2, when police engage their emergency lighting system to alert other motorists of a stop that an interaction is initiated.

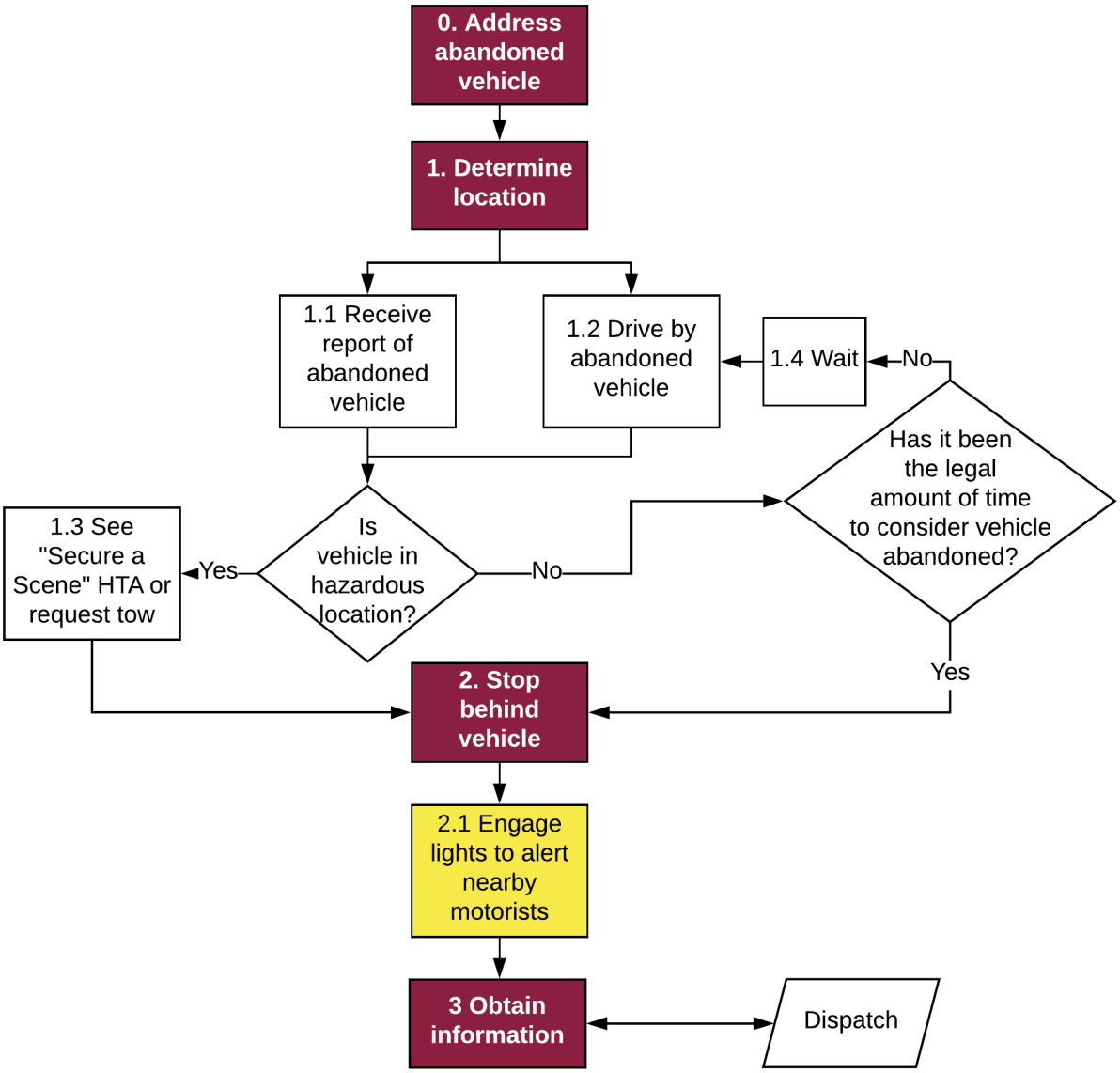



**Figure 45. Address abandoned vehicle subtasks 1 and 2.**

*4.2.3.4 Subtask 3: Obtain Information*

Police must obtain key information about the vehicle and check it against a database. The database will determine if the vehicle is wanted or stolen or if the owner has any prior convictions that may warrant taking other actions. First, from inside their own vehicle, police visually scan the interior of the abandoned vehicle to confirm that it is abandoned and no one is inside it. Police may use technology to automatically scan a license plate but may also write down or read the license plate into the radio. Then they take note of the vehicle's color, make, model, and other identifying characteristics. This information is relayed to dispatch. Dispatch may then attempt to contact the last registered owner of the vehicle and if the owner is able to

remove the vehicle in a reasonable amount of time, the police officer will wait at the vehicle (San Jose Police, 2018). If a vehicle's license plate has been removed, police will identify the vehicle via the Vehicle Identification Number (VIN) number (see Appendix D, Item No. 67).

Figure 46 shows the three major interactions, all informational exchanges that are necessary for obtaining information from a potentially abandoned vehicle.

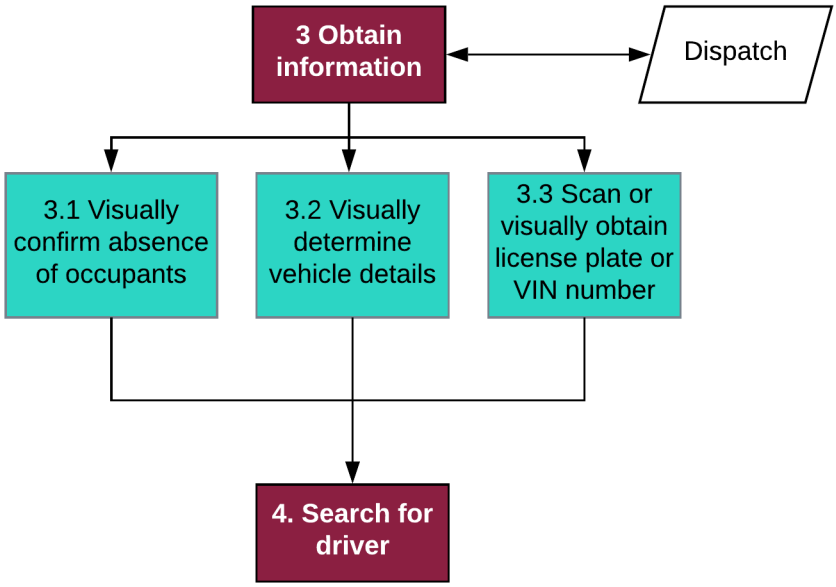



**Figure 46. Address abandoned vehicle subtask 3.**

*4.2.3.5 Subtask 4: Search for Driver*

If time and resources allow, police may begin a brief search for the driver of the abandoned vehicle (see Appendix D, Item No. 68). First, police will make a closer inspection of the abandoned vehicle and confirm there are no occupants. This search is conducted primarily to ensure the driver is not present, but to also ensure there are no vulnerable occupants trapped in the vehicle. Police may inspect the area nearby the vehicle and in the vehicle's general vicinity (e.g., over guardrails, down embankments) for anyone who could have been the driver. This inspection also includes scanning up and down the roadway for people walking, especially if the vehicle is left on a highway. Police may attempt to determine if the vehicle has been parked for only a short amount of time by feeling the hood of the vehicle to see if it is still warm (C. Carroll, personal communication, May 26, 2018). If the vehicle is abandoned on a highway, police may drive to a nearby exit searching for people walking in an attempt to locate the driver

or provide assistance, but this depends on the individual officer and the volume of police calls at the time.

Police generally do not perform subtasks 4.2, 4.3, or 4.4 for vehicles left on private property or parked in a public parking facility. This is because in these scenarios vehicles must be abandoned for an extended amount of time, typically for up to 48 hours, before police respond and it can be assumed that the person who left the vehicle is no longer in the vicinity. Not every jurisdiction requires police to respond to calls for abandoned vehicles on private property, as those will often be directly towed by the property owner.

As part of the investigation of the vehicle, a larger vehicle's cargo may be of interest if the vehicle is parked suspiciously (see Appendix D, Item No. 69).

Figure 47 illustrates subtask 4, which includes one visual informational interaction in subtask 4.1 and one potential direct physical interaction in subtask 4.4.

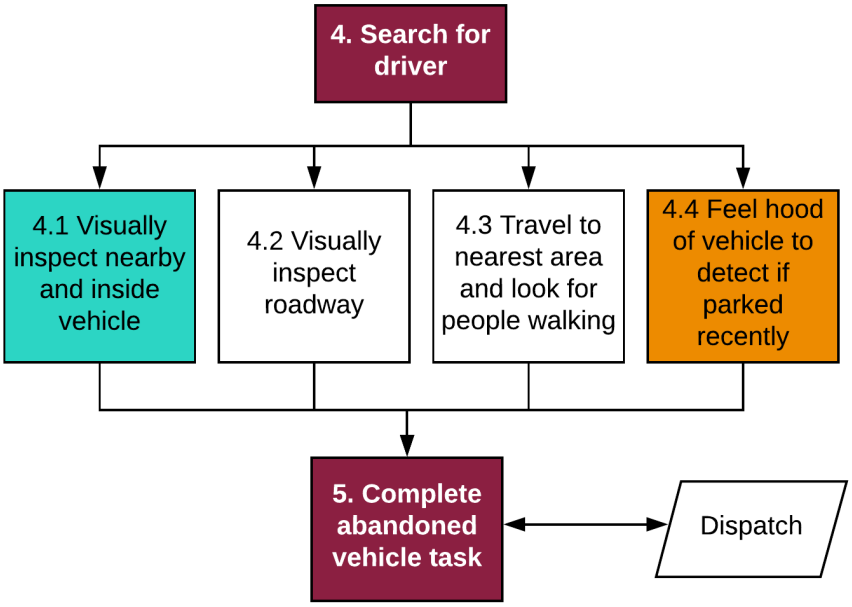



**Figure 47. Address abandoned vehicle subtask 4.**

*4.2.3.6 Subtask 5: Complete Abandoned Vehicle Task*

Extra attempts to contact the driver may include the officer driving to the address registered to the vehicle if it is nearby or dispatch requesting another officer to visit the home if within the jurisdiction. Otherwise, dispatch may contact the driver registered to the vehicle via phone

before resorting to towing the vehicle (C. Carroll, personal communication, May 26, 2018). A time limit for a vehicle may be relaxed if the owner intends to have the vehicle removed within a reasonable time (see Appendix D, Item No. 70).

If a driver is located, police may opt to provide assistance to the motorist depending on the issue. These actions are detailed in Section 4.2.2 Assist Motorist. If the driver is not located and the required time for a vehicle to be considered abandoned has passed, police will place an "abandoned" tag, usually a highly visible sticker, on the vehicle that can be seen by traffic approaching from the rear. This is to indicate to tow operations that the vehicle has been considered abandoned and can be towed.

The task analysis concludes at subtask 5 as shown in Figure 48, where the last highlighted interaction in the abandoned vehicle operation is to physically place the "abandoned" sticker on the rear of the vehicle. All interactions associated with the operation are detailed in Table 11.

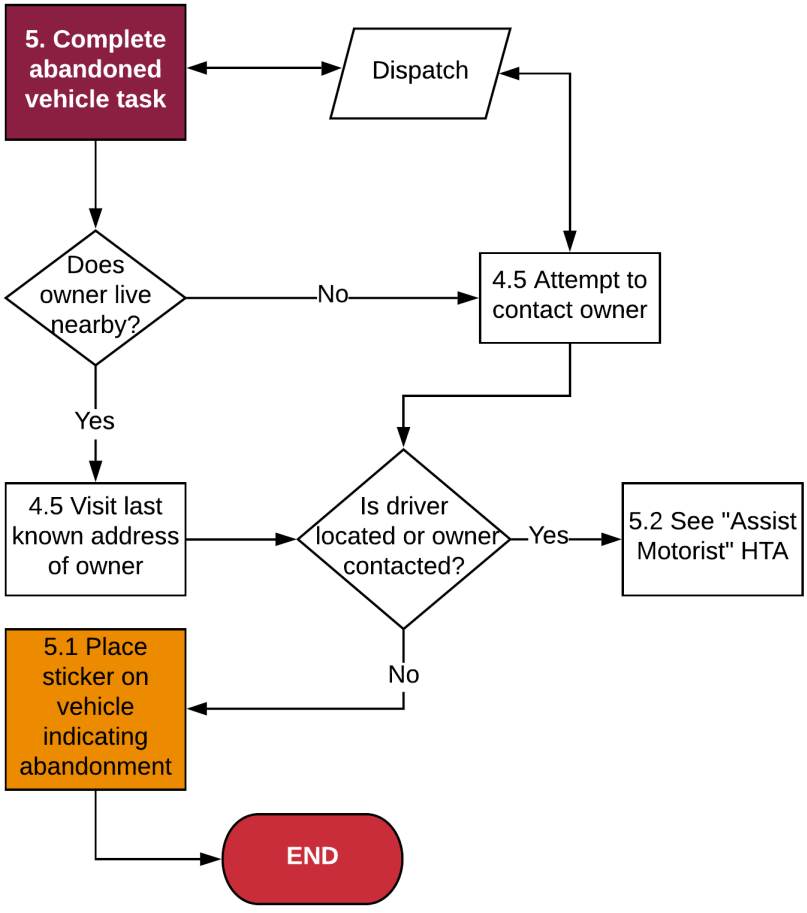



**Figure 48. Address abandoned vehicle subtask 5.**

**Table 11. Interaction Types, Descriptions, and Contingencies for Address Abandoned Vehicle Subtask**

| Task | Interaction Type | Interaction Description | Contingency or Standard Procedure |
|---|---|---|---|
| 2.1 | Indirect | Engage lights to alert nearby motorists | Standard operating procedure |
| 3.1 | Informational | Visually confirm absence of occupants | Standard operating procedure |
| 3.2 | Informational | Visually determine vehicle details | Standard operating procedure |
| 3.3 | Informational | Visually note or automatically scan license plate number | Standard operating procedure |
| 4.1 | Informational | Visually inspect inside of vehicle up close | Standard operating procedure |
| 5.1 | Direct | Place abandonment tag on rear of vehicle | No driver is located and vehicle has been unattended for specified duration |

| | |
|---|---|
| **Direct:** | Physical interaction between a public safety officer and the subject vehicle |
| **Indirect:** | Communication via lights and sirens, maneuvering by positioning public safety vehicle for traffic control and access |
| **Informational:** | Public safety officer gathers information (e.g., electronically scans license plate to determine ownership) |

### 4.2.4 Checkpoints and Roadblocks

Checkpoints and roadblocks are similar operations conducted for different reasons. Checkpoints may be operations that a jurisdiction routinely carries out (such as sobriety checkpoints) or can be initiated due to the need to locate a specific vehicle or person. Locations for checkpoints are predetermined but the vehicles checked can vary. Some checkpoints seek to stop every vehicle while others use selection intervals, such as every two or three vehicles (Centers for Disease Control and Prevention, 2015; Florida Highway Patrol, 2015; National Highway Traffic Safety Administration, 2009). Ten states (Idaho, Iowa, Michigan, Minnesota, Oregon, Rhode Island, Texas, Washington, Wisconsin, and Wyoming) do not allow sobriety checkpoints, citing their own state constitutions as prohibiting them (Centers for Disease Control and Prevention, 2015; Mothers Against Drunk Driving, 2012).

**Figure 49. Example of a checkpoint.**

Some states, such as Florida, regularly conduct vehicle safety inspection checkpoints and driver's license checkpoints. These checkpoints are mandated to occur during the day and absent of inclement weather. During a safety inspection checkpoint, police

inspect vehicle features that are required to pass a safety inspection, asking drivers to activate such features as the horn, windshield wipers, brakes, tail lamps, directional signals, and headlamps (Figure 49). Also, during the stop, officers will take note of license plate lamps, tires, the exhaust system, and other readily visible equipment. During these stops, police do not ask drivers for their driver's license or registration. At driver's license checkpoints, police request that drivers provide their license, vehicle registration, and proof of insurance similar to a routine traffic stop (Florida Highway Patrol, 2015).

Locations for checkpoints must be preselected as safe areas with high visibility that include electric warning signs, law enforcement vehicles, and flares (Centers for Disease Control and Prevention, 2015; National Highway Traffic Safety Administration, 1999). Warning signs and marked patrol cars with active emergency lights are positioned upstream from checkpoints to alert approaching motorists to be ready to stop (Florida Highway Patrol, 2015). Vehicles are ushered through the checkpoints by police who manually wave vehicles through to the next available officer. Drivers are expected to stop and roll down their windows. The officer may ask to see a driver's license while using passive alcohol sensors to detect the presence of alcohol. If police suspect that a driver may be impaired or is in violation of the law, they will request that the driver pull their vehicle aside to a screening area to engage in a more thorough interaction (Florida Highway Patrol, 2015).

#### *4.2.4.1 Overall Plan: Conduct Checkpoint*

The goal of this operation is to choose a safe location where the inspection of motorist or vehicle validity can be conducted.

#### *4.2.4.2 Subtask 1: Select Checkpoint Location*

The first step to conducting any checkpoint operation is to choose a safe location. The location must include ample visibility for the motorist to be able to recognize and stop for the checkpoint (W. Blydenburgh, personal communication, May 31, 2018). Additionally, a checkpoint area must have space for a staging area. This area is reserved for motorists whom police determine need further questioning or attention (Florida Highway Patrol, 2015).

**Figure 50. Officers conducting a checkpoint featuring a warning zone and visual inspections.**

A key part of the operation is setting up an advanced warning zone to alert motorists to proceed with caution and be prepared to stop (Figure 50). Police park their vehicles upstream from the checkpoint in either direction, provided the checkpoint is monitoring traffic from both directions. This configuration depends on the goal of the checkpoint and the road type and location. Police vehicles will be parked on the shoulder and have their emergency lights engaged to alert motorists. Similar to aspects of section 4.1.2 Secure a Scene and section 4.1.3 Traffic Direction and Control, police may park before the crest of a hill or in the apex of a curve to warn motorists as soon as possible. Subtasks 1 and 2 are shown in Figure 51.

#### *4.2.4.3 Subtask 2: Motion Vehicles Through and Visually Scan*

As vehicles pass through a checkpoint, several law enforcement officers may be in line to inspect different vehicles in the queue. As vehicles approach, police are taught to scan the interior of the vehicle for weapons or other contraband. As a vehicle stops, police expect the driver's window to be down and, if not, police may knock on the window. Through conversation with the driver, police will ask for licensure and/or vehicle registration (W. Blydenburgh, personal communication, May 31, 2018).

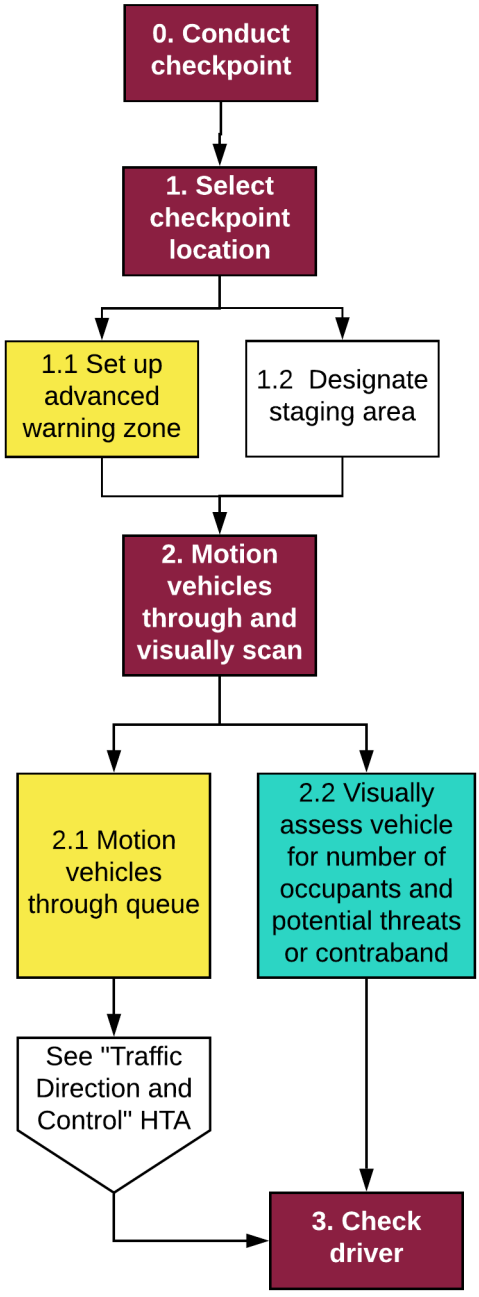



**Figure 51. Conduct checkpoint subtasks 1 and 2.**

*4.2.4.4 Subtask 3: Check Driver*

Police are trained to evaluate drivers for signs of alcohol or drug impairment (National Highway Traffic Safety Administration, 2002). As noted, they may also incorporate the use of a passive alcohol sensor, which reads the content of air for the presence of alcohol; this sensor is often built into the end of a flashlight (Fell, Compton, & Voas, 2008). Should a driver require further attention or investigation, police will request that the vehicle pull into the staging area, which is

typically an adjacent coned-off lane. After the vehicle is staged, police may ask the driver to exit the vehicle. If the driver is determined to be too intoxicated to drive or if licensure has not been produced, the vehicle will be driven out of the lane by law enforcement to be towed later (see Appendix D, Item No. 71). Like a traffic stop, if a driver cannot produce the required documentation, they may be asked to step out of the vehicle and subsequent actions outside of the scope of this analysis may be conducted. A driver may be motioned out of a checkpoint without being checked depending on the protocol in place as police may only check every second or third vehicle. If a vehicle is stopped a checkpoint and no further actions are required, police will motion that vehicle out of the checkpoint (National Highway Traffic Safety Administration, 2002) (Figure 52).

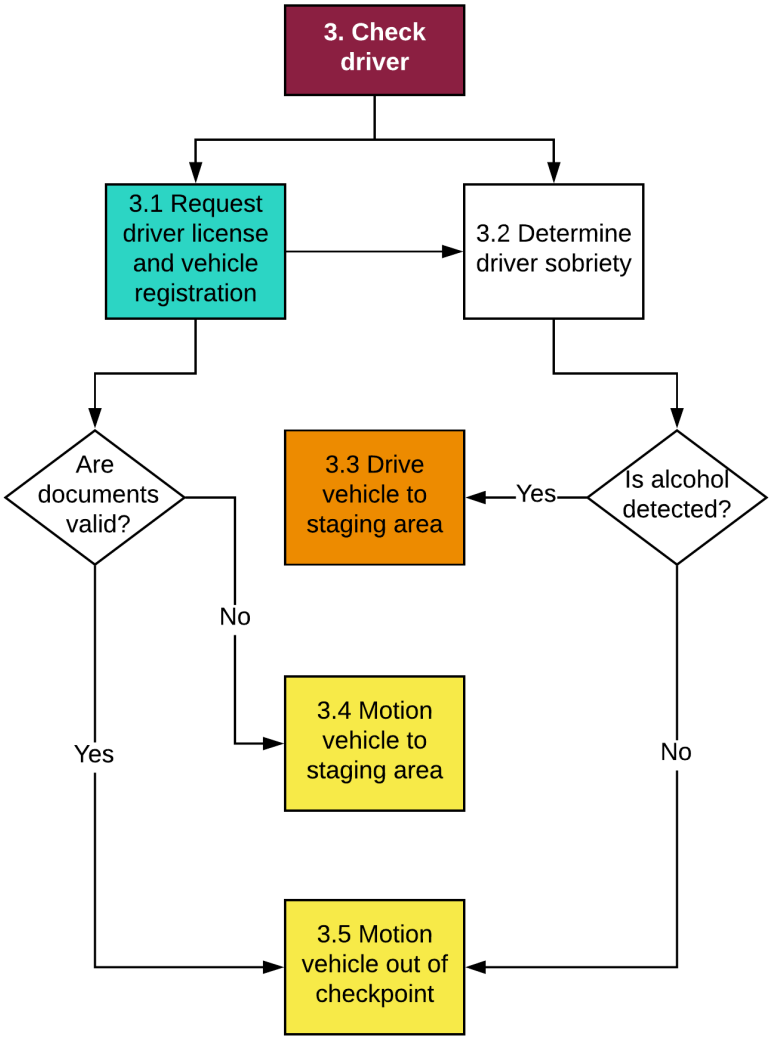



**Figure 52. Conduct checkpoint subtask 3.**

There are no direct interactions in the checkpoint operation, although a search of the vehicle could be conducted if law enforcement found probable cause. The overall operation is similar to a traffic stop in the types of informational interactions and similar to securing a scene in terms of advanced warnings (Table 12).

**Table 12. Interaction Types, Descriptions, and Contingencies for Conduct Checkpoint Subtask**

| Task | Interaction Type | Interaction Description | Contingency or Standard Procedure |
|---|---|---|---|
| 1.1 | Indirect | Set up advance warning zone | Standard operating procedure |
| 2.1 | Indirect | Motion vehicles through queue | Standard operating procedure |
| 2.2 | Informational | Visually assess vehicle for number of occupants and potential threats | Standard operating procedure |
| 3.1 | Informational | Request driver's license and vehicle registration from driver | Standard operating procedure |
| 3.3 | Direct | Drive vehicle to staging area | If driver fails sobriety test |
| 3.4 | Indirect | Motion vehicle to staging area | If driver fails to produce requested documents or law enforcement detects alcohol |
| 3.5 | Indirect | Motion vehicle out of checkpoint | If vehicle passes checkpoint |

| | |
|---|---|
| **Direct:** | Physical interaction between a public safety officer and the subject vehicle |
| **Indirect:** | Communication via lights and sirens, maneuvering by positioning public safety vehicle for traffic control and access |
| **Informational:** | Public safety officer gathers information (e.g., electronically scans license plate to determine ownership) |

### 4.2.5 Other Operations

While the scope of this literature review includes common representative operations where public safety authorities interact with vehicles, some operations are either so uncommon or abrupt in their tasks that representing them in the form of a task analysis is not appropriate.

One such example is that of a police escort. Police escorts can be requested for a number of reasons, including providing protection for a dignitary, keeping a large group together through the flow of traffic, movement of oversized vehicles through a congested area, or a funeral procession. The general premise of these actions for law enforcement is to be a presence and pace traffic in addition to providing protection. During an escort operation, police simply navigate a predetermined route at an adequate pace that allows the convoy to follow. Most escort operations include a lead vehicle as well as a tail vehicle. The lead vehicle leads the convoy and the tail vehicle prevents following traffic from interrupting the convoy. Depending on the level of significance, more law enforcement vehicles may be required (City of Madison Police Department, 2016; State of New Jersey, 2012).

Funeral processions are convoys of friends and family following a hearse from a funeral home to a burial site. In most cases, a funeral procession is facilitated by a law enforcement vehicle and each vehicle in the convoy will be provided a funeral procession tag or flag to place on the vehicle to signify to others that they are a part of the convoy. However, not all processions are accompanied by law enforcement and not all funeral facilities provide visible tags for the convoy. Each state has its own laws for how processions are governed in terms of right-of-way and whether certain traffic laws can be excused. In most cases, other motorists are prohibited from cutting the line of a procession by traveling through or merging between the convoy. Other stipulations include the ability for police to proceed through intersections and traffic signals when leading a convoy (Wickert, 2017).

In general, there are no direct or informational tasks on the part of public safety authorities in regard to funeral processions; however, vehicles are expected to recognize a funeral procession and understand when to grant the right-of-way.

Lastly, a rare law enforcement interaction is vehicle commandeering, or when law enforcement must take control of a civilian vehicle in pursuit of a criminal or in response to an emergency. In fact, scant literature or policy is available on the topic and the act itself appears to be extremely uncommon.

## 4.3 Fire and Rescue

Emergency medical and/or rescue incidents account for 67% of all fire and rescue department responses to roadway incidents, making them the most common form of contact (Ahrens & Evarts, 2017). The clear majority of these roadway incident interactions are emergency medical incidents, such as a vehicle crashes with injury (21%), EMS calls for an injured person not involved in a vehicle crash (20%), and a vehicle crash with no injuries (13%). Less frequent incidents include extrication from vehicles (1%) and lock-ins (< 1%) (Ahrens & Evarts, 2017). Fire and rescue interactions involve both direct interactions with vehicles, such as stabilization and extrication, as well as indirect contact (e.g., responding to an incident call with lights and sirens, temporary traffic control of an incident scene involving vehicle placement and/or cones and flares to block and taper lanes) using procedures laid out in the Traffic Incident Management, MUTCD, or the local jurisdiction equivalent (FDNY, 2016; Federal Highway Administration, 2010; National Highway Traffic Safety Administration, 2009).

### 4.3.1 Stabilize Vehicle

Vehicle stabilization is the process of immobilizing a vehicle to prevent movement (National Fire Protection Association, 2017; Sweet, 2012). This creates a secure environment for the first responders to work.


**Domain:**
Fire and Rescue

#### *4.3.1.1 Overall Plan: Stabilize Vehicle*

The goal of this task for fire and rescue personnel is to use trained techniques and equipment to prevent a vehicle from moving during an extrication procedure.

#### *4.3.1.2 Subtask 1: Inspect Vehicle & Subtask 2: Immobilize and Access Interior*

The first task is to visually inspect the area immediately around the vehicle. This ensures no occupants are trapped under the vehicle and informs the fire and rescue team of the vehicle's positioning (e.g., vehicle on side, roof, near a ledge or incline). The next task is to visually assess the interior of the vehicle to determine the presence and location of any occupants.

If the vehicle is on all four wheels, first responders will proceed with immobilizing and accessing the interior (subtask 2).

Immobilizing the vehicle requires placing chocks/cribbing and possibly cutting the valve stems on the tires to prevent the vehicle from moving. Once the vehicle is immobilized, fire and rescue personnel will attempt to enter the vehicle through the doors, if possible, checking to see if they are unlocked and damage does not prevent entry. If the doors are locked or damage to the vehicle has made them inoperable, first responders will force entry by breaking a window, jimmying the door latch, or via other means (FDNY, 2016). If the doors are unlocked, first responders will proceed to subtask 3 (Park Vehicle and Turn Off Engine).

If the vehicle is not on all four wheels, but is rather on its side or roof, first responders need to determine if it is safe to access the interior (Figure 53). If the vehicle is determined to be safe, first responders turn off the engine, which—depending on the make and model of the vehicle—can require first putting the vehicle in park (subtask 3). If it is unsafe to access the interior, the next step is to anchor the vehicle and disconnect the power (subtask 4). These steps are illustrated in the task analysis shown in Figure 54.

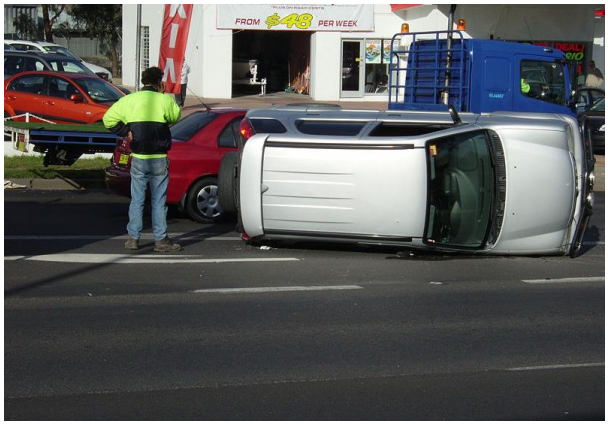



**Figure 53. Example of a vehicle requiring stabilization.**

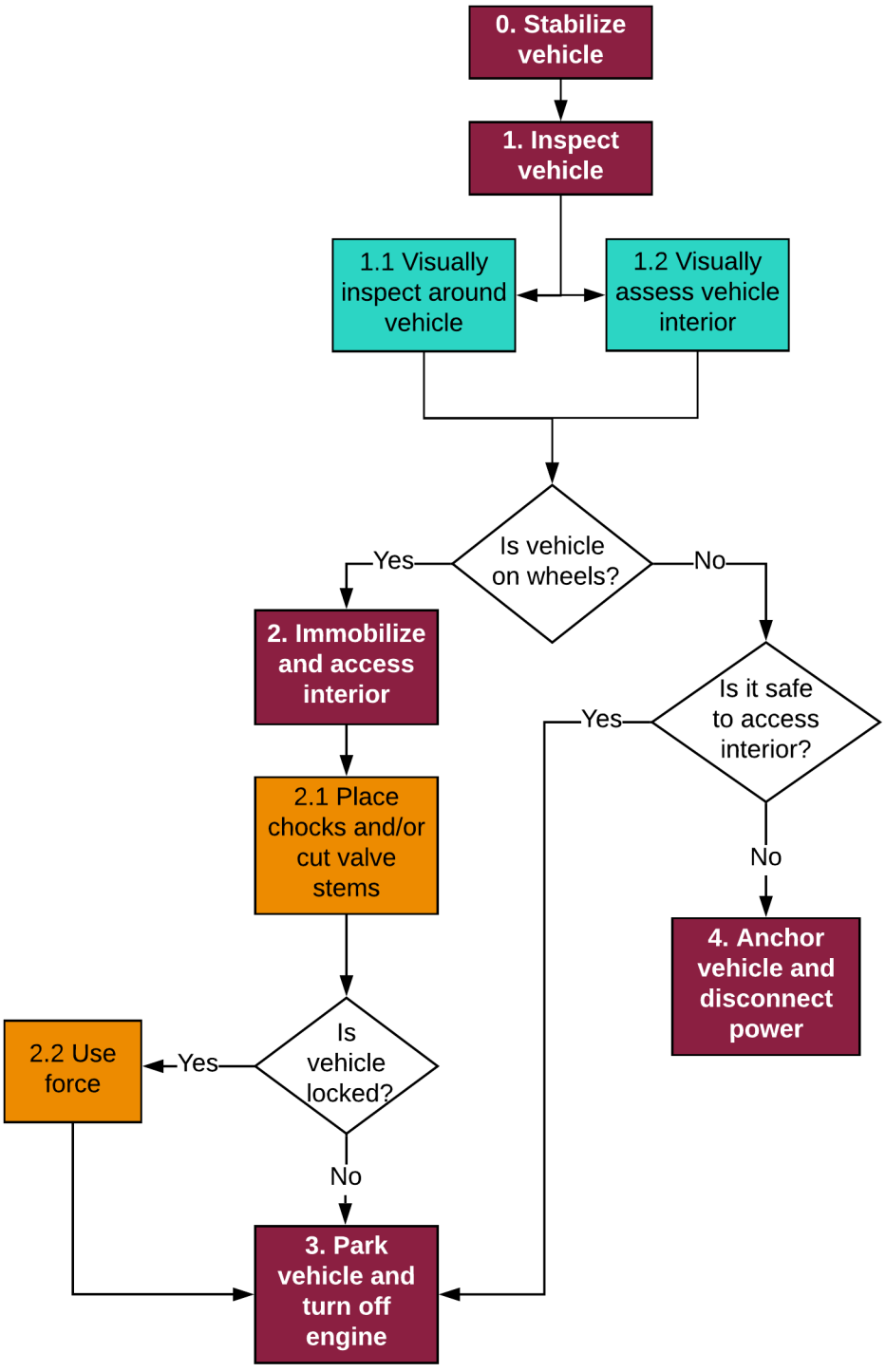



**Figure 54. Stabilize vehicle subtasks 1 and 2.**

#### *4.3.1.3 Subtask 3: Park Vehicle and Turn off Engine & Subtask 4: Anchor Vehicle and Disconnect Power*

Next, fire and rescue personnel will, if possible, open the vehicle door and ensure the vehicle is in park, check that the parking/emergency brake is engaged, open power windows, and adjust power seats backwards as shown in Figure 55.

Additional stabilization and anchoring of the vehicle may be required. Supplementary cribbing may be used under the body frame to essentially wedge the vehicle in place and prevent movement on any axis. If the vehicle is on its side or at an unstable angle, fire and rescue will anchor the vehicle with ropes and/or chains to a heavy object, such as an apparatus or tree, to prevent the vehicle from shifting. If the vehicle is electric, fire and rescue personnel need to consult reference manuals to determine how best to disable the high voltage. They will then confirm that the vehicle is off and resume extrication. If the vehicle is not electric, the ignition is turned off, the key or fob is removed from the vehicle to prevent vehicle ignition, and the 12-V battery is disabled. Once the crew has confirmed that the vehicle is off, occupant extrication can resume (See section 4.3.1.5 Subtask 5: Critical Trauma Assessment & Subtask 6: Extricat). If an occupant is inside the vehicle or is able to respond to public safety officials on scene, they may be requested to power down the vehicle in the event they are able to do so. This may be necessary if first responders cannot access the interior of the vehicle or if they are unfamiliar with how the vehicle is operated and the occupant is more familiar and able to complete the task (see Appendix D, Item No. 72).

Larger vehicles that require stabilization will require longer and larger operations. Larger traffic control operations may also be required depending on the situation (see Appendix D, Item No. 73).

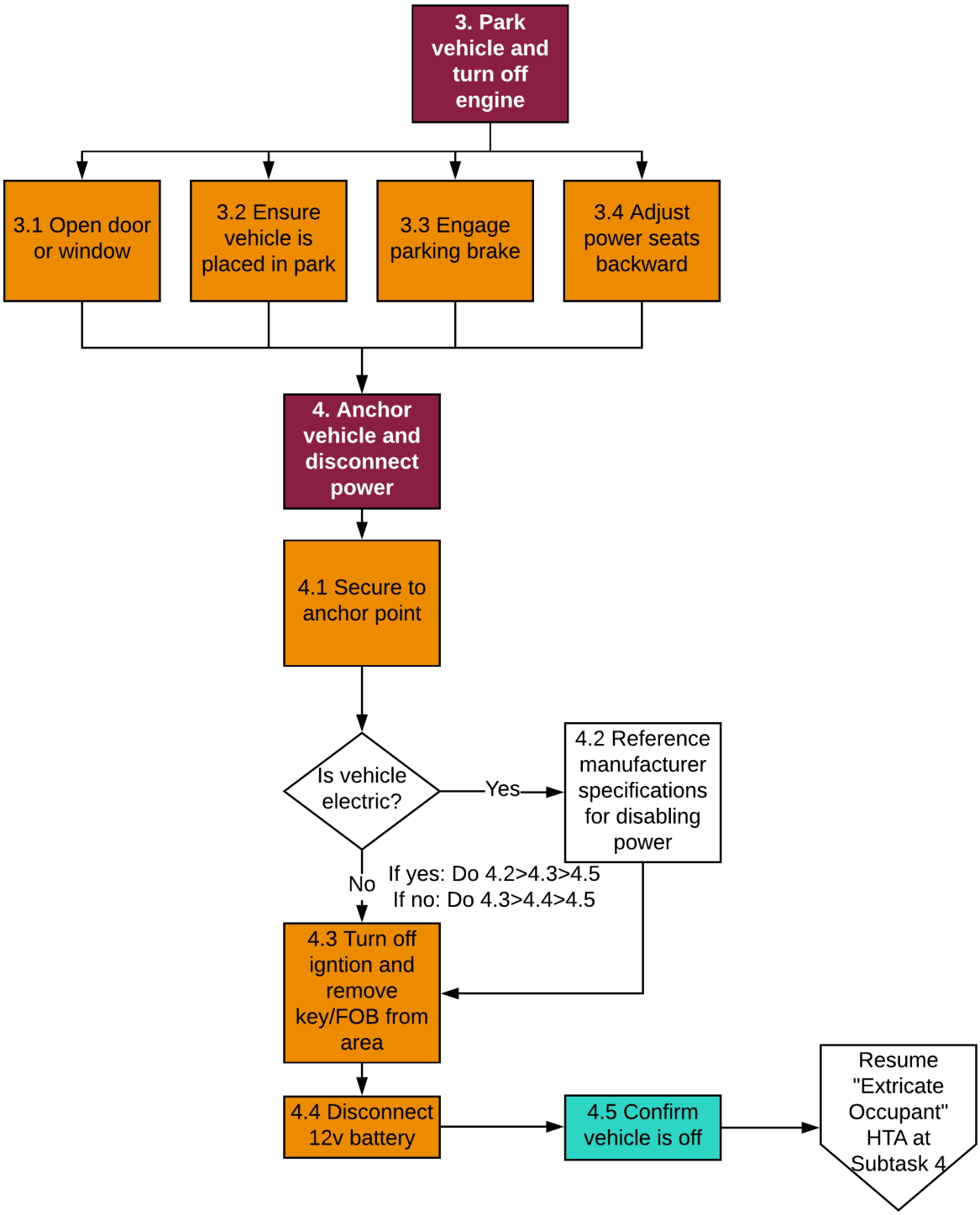



**Figure 55. Stabilize vehicle subtasks 3 and 4.**

Stabilization of a vehicle, which is required when the vehicle has an occupant who requires extrication or is at risk of increased hazard if not stabilized, has many direct interactions. The informational interactions during the operation involve visually inspecting in and around the

vehicle for potential hazards or trapped occupants. Direct interactions mainly involve adjusting components within the vehicle to create more space for extrication; adjustments may include opening windows, doors, and adjusting seats. Additionally, placing the vehicle in park, engaging the parking brake, and turning off the engine should ensure the vehicle stays in place. Other direct interactions, such as placing chocks, cutting valve stems, or disconnecting the battery are contingent on the position of the vehicle (upright, on its side or roof) and how the vehicle is powered (conventional, hybrid, or electric). See Table 13 for interaction types.

**Table 13. Interaction Types, Descriptions, and Contingencies for Stabilize Vehicle Operation Subtask**

| Task | Interaction Type | Interaction Description | Contingency or Standard Procedure |
|---|---|---|---|
| 1.1 | Informational | Visually inspect around vehicle for hazards and occupants | Standard operating procedure |
| 1.2 | Informational | Visually assess vehicle interior for hazards and occupants | Standard operating procedure |
| 2.1 | Direct | Place chocks and/or cut valve stems | If vehicle is on wheels and needs to be immobilized |
| 2.2 | Direct | Use force | If interior needs access and doors are locked or jammed |
| 3.1 | Direct | Open window or door | Standard operating procedure |
| 3.2 | Direct | Ensure vehicle is placed in park | Standard operating procedure |
| 3.3 | Direct | Engage parking brake | Standard operating procedure |
| 3.4 | Direct | Adjust power seats backward | Standard operating procedure |
| 4.1 | Direct | Secure anchor point | If vehicle is not upright or it is otherwise unsafe to access the interior of the vehicle |
| 4.3 | Direct | Turn off ignition and remove key/fob from area | If vehicle is not electric and still on |
| 4.4 | Direct | Disconnect 12-V battery | If vehicle is not electric |
| 4.5 | Informational | Confirm vehicle is off | Standard operating procedure |

**Direct:** Physical interaction between a public safety officer and the subject vehicle
**Indirect:** Communication via lights and sirens, maneuvering by positioning public safety vehicle for traffic control and access
**Informational:** Public safety officer gathers information (e.g., electronically scans license plate to determine ownership)

### 4.3.1 Extricate Occupant

Extrication is defined by Sweet as the "process of removing a trapped patient [i.e., occupant] from a vehicle or machinery." This process involves disentangling the patient from a vehicle by means of spreading, cutting, and/or removal of vehicle pieces and parts (Sweet, 2012, p. 2). While this operation is a relatively rare event, accounting for only 1% of all fire and rescue responses in 2014 (Ahrens & Evarts, 2017), it is the most direct contact that fire and rescue units have with a vehicle.

#### *4.3.1.1 Overall Plan: Extricate Occupant from Vehicle*

The ultimate goal of this task is to safely remove an occupant trapped in a vehicle.

#### *4.3.1.2 Subtask 1: Receive Notice of Trapped Occupant*

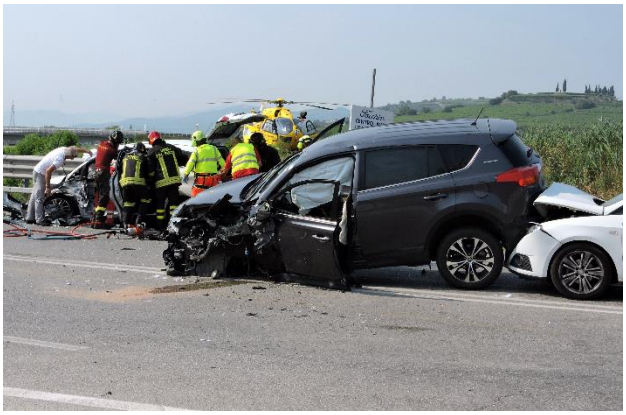


**Figure 56. Example of firefighters extricating a patient.**

Typically, fire and rescue will receive notification from a dispatcher that an occupant has been physically trapped in a vehicle and needs to be extricated (Figure 56). The information provided by dispatch can detail the number of trapped occupants, the status of the trapped occupants (if available), and the condition of the vehicle or vehicles (e.g., on all four wheels, on vehicle side, on vehicle roof) (Figure 57).

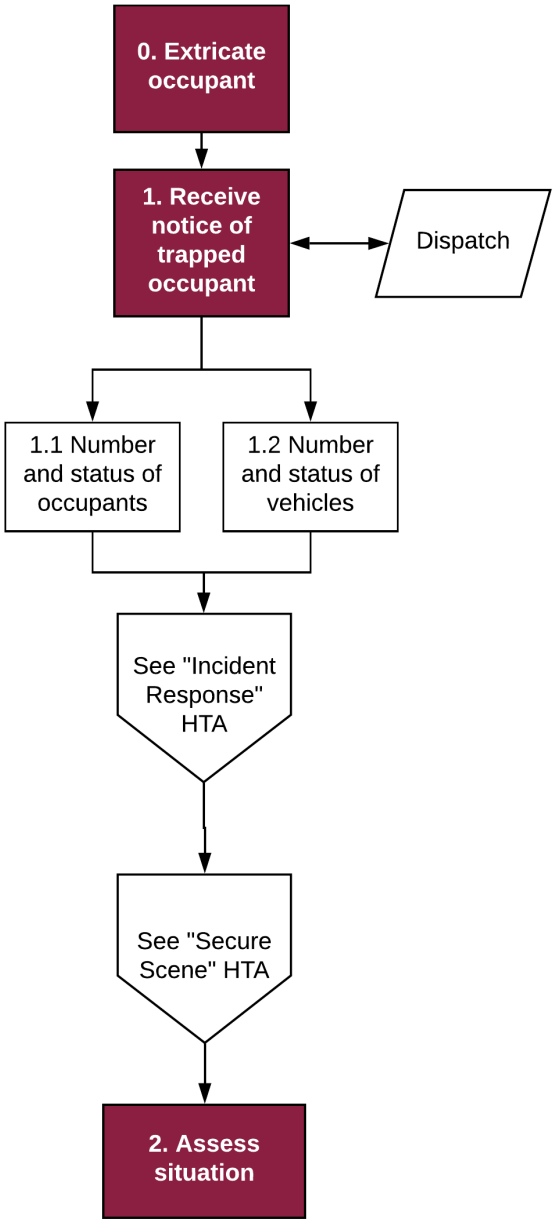



**Figure 57. Extricate occupant subtask 1.**

*4.3.1.3 Subtask 2: Assess Situation*

The next subtask is for the fire and rescue crew to arrive on the scene. Once on the scene, they will begin securing the incident scene, a task which was described in more detail in section 4.1.2 Secure a Scene. This allows fire and rescue to assess the situation and update dispatch. During this process, requests for additional units (such as EMS, fire and rescue, or law enforcement) will be made if necessary. Next, any nearby hazards, such as downed electrical lines, fluid spills, and/or other hazards, will be noted. Fire and rescue members will then confer with the first

responders on the scene and perform a visual assessment of the incident scene to confirm the first responders' incident information (vehicle type, occupants, and injuries). Team members will also note other potential hazards, such as restricted or impaired sightlines and the potential for secondary crashes. With this information, fire and rescue will create control zones, colloquially known as "hot, warm, and cold," which are designed to restrict access to the scene. The hot zone is the closest to the incident and contains only workers who are actively trying to extricate the patient, while the warm zone, immediately adjacent to the hot zone, is designated for workers who are directly supporting those in the hot zone. Finally, the cold zone is for equipment staging and crowd control (International Fire Service Training Association, 2013).

Figure 58 illustrates the process of assessing the situation and beginning stabilization.

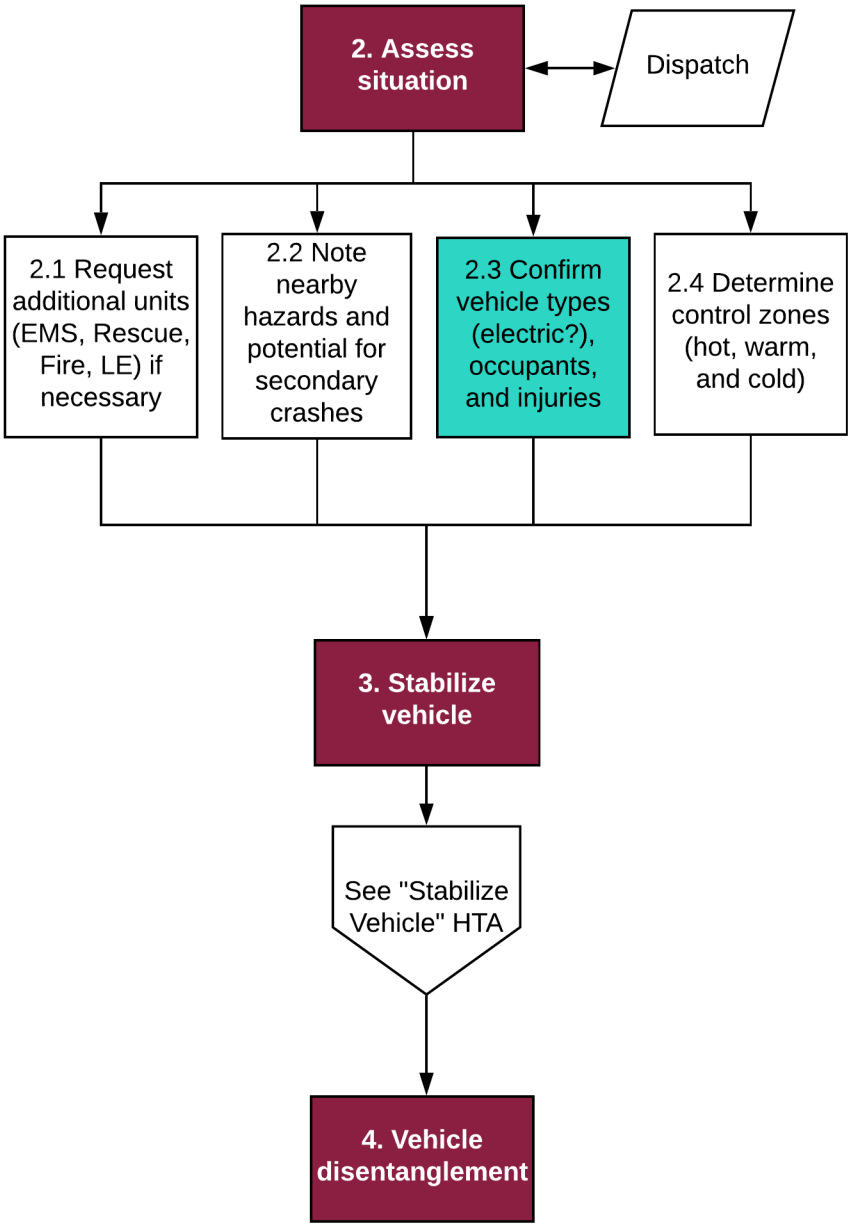



**Figure 58. Extricate occupant subtasks 2 and 3.**

*4.3.1.4 Subtask 3: Stabilize Vehicle & Subtask 4: Vehicle Disentanglement*

For an in-depth breakdown of the stabilization procedures, refer to section 2.3.2 Stabilize Vehicle. Any time an extrication is necessary, stabilizing the vehicle is the first task. Fire and rescue will then determine a strategy to enter the vehicle by cutting, prying, and, in general, disentangling and removing vehicle parts that restrict access to the occupant. There are a number of possible avenues to achieve this goal, such as removing doors, windows (side, forward, or rear), pillars, the roof, gaining access through the trunk, or in some instances cutting through the

floorboard of the vehicle (FDNY, 2016; International Fire Service Training Association, 2013; Sweet, 2012). If the vehicle is electric or a hybrid electric (xEV), the department can use NFPA's Electric Vehicle Field Guide as well as vehicle-specific safety guides to determine additional safety precautions on how to disable the high-voltage systems, as well as avoid cutting or piercing high-voltage components or cabling (National Fire Protection Association, 2015). The on-scene incident commander will ultimately determine the best course based on several factors, such as risk of additional injuries to the occupant, time, and safety constraints (S. Fritz, personal communication, May 31, 2018). As noted in subtask 3, in most cases, vehicle stabilization is required to prevent the vehicle from moving. In more extreme cases, vehicle stabilization is used to prevent the structural integrity from deteriorating while the occupant is still trapped inside (FDNY, 2016).

#### *4.3.1.5 Subtask 5: Critical Trauma Assessment & Subtask 6: Extricate*

Once the vehicle is stable, external hazards have been controlled, and access to the occupant, who is considered a patient at this point, is viable, fire and rescue and/or EMS will assess trauma and medically stabilize and apply treatment (Hallinan, 2015). Once enough wreckage has been removed and there is sufficient room to get to the patient, fire and rescue and/or EMS personnel will physically extricate the patient and provide care or move them to be transported to the hospital. If there is more than one patient, fire and rescue will continue disentanglement and extrication operations until all patients have been freed from the vehicle (FDNY, 2016; Hallinan, 2015). Figure 59 illustrates subtasks 3, 4, 5, and 6.

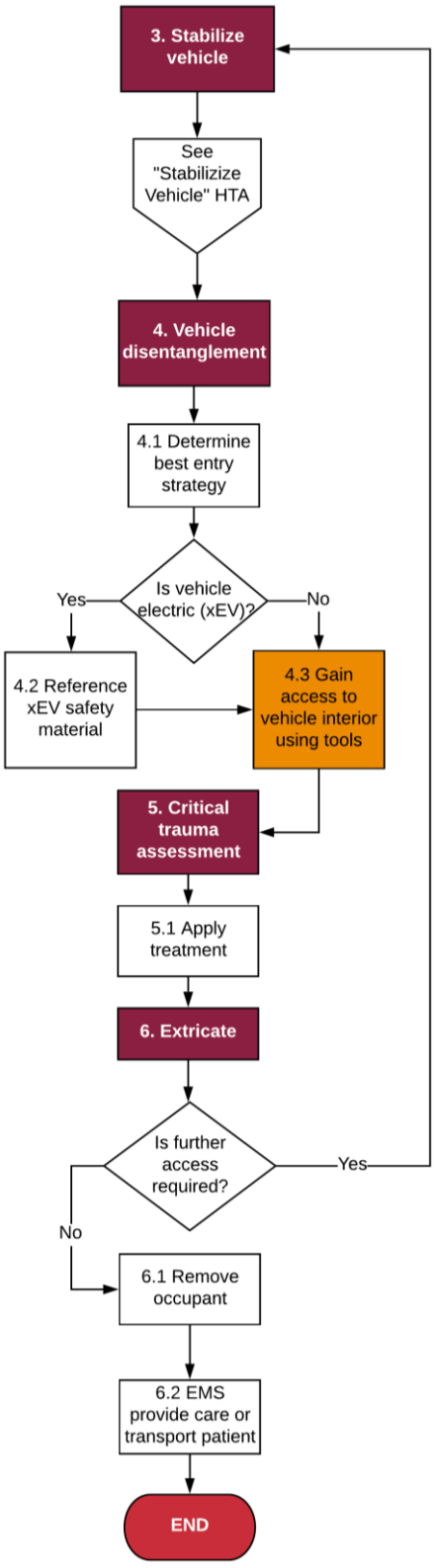



**Figure 59. Extricate occupant subtasks 3, 4, 5, and 6.**

Although extrication can involve extensive direct contact in terms of cutting open portions of the vehicle to access the interior, there are only two primary interactions public safety officers have during the procedure. Informational interactions apprise the rescue team of the safest way to access a vehicle's interior if there are concerns with potential electrical hazards posed by hybrid and electric vehicles. The specific interactions involved in subtask 4.3 will depend greatly on the number of occupants, where they are located, their condition, and the position and orientation of the vehicle post-crash (Table 14).

**Table 14. Interaction Types, Descriptions, and Contingencies for Extricate Occupant Subtask**

| Task | Interaction Type | Interaction Description | Contingency or Standard Procedure |
|---|---|---|---|
| 2.3 | Informational | Visually confirm vehicle types (electric?), occupants, and injuries | Standard operating procedure |
| 4.3 | Direct | Gain access to vehicle using tools | Depends on vehicle type, vehicle position, and position of trapped occupant |

| | |
|---|---|
| **Direct:** | Physical interaction between a public safety officer and the subject vehicle |
| **Indirect:** | Communication via lights and sirens, maneuvering by positioning public safety vehicle for traffic control and access |
| **Informational:** | Public safety officer gathers information (e.g., electronically scans license plate to determine ownership) |

## 4.4 Emergency Medical Services (EMS)

EMS, in its broadest terms, can be defined as a "system that provides emergency medical care" (EMS.gov, p. 1). EMS functions at the crossroads of public health, public safety, and health care. Because EMS responds to emergency medical incidents, they often work alongside law enforcement, and fire and rescue services. EMS prehospital services can be based in fire departments, hospitals, third-party government agencies, non-profits (e.g., rescue squads), or as private commercial entities (EMS.gov). Most are based in fire departments (40%), followed by private non-hospital entities (25%), other government agencies (21%), hospitals (6%), other EMS providers (6%), emergency medical dispatch services (2%), and tribes (1%) (Federal Interagency Committee on Emergency Medical Services, 2011). The majority (58.6%) of fire departments now provide basic life support, with a smaller subset (20.8%) providing advanced life support (U.S. Fire Administration, 2018). According to the American Red Cross, basic life support includes skills such as cardiopulmonary resuscitation (CPR), the use of automated external defibrillators (AED) and removing and/or relieving airway obstructions in a patient (American Red Cross, 2018, p. 1). Advanced life support is a higher level of care that can

include skills and tasks such as cardiac monitoring, intubation, and administering intravenous (IV) medications (FC Emergency Medical Services, 2018, p. 5).

Fire-department-based EMS systems can be organized into many different configurations based on specific needs, but will generally be in one of three arrangements: 1) having firefighters who are cross-trained and available to handle multiple roles, known as all-hazards-responders, 2) having single-role EMS-trained members who accompany the firefighters during emergency calls, or 3) a combination system in which single-role Emergency Medical Technicians (EMTs) and/or paramedics accompany firefighters to incident scenes to provide medical support, and then hand off medical transportation responsibilities to a third party such as a private EMS provider (Pratt, Pepe, Katz, & Persse, 2007).

As a definitional matter, there are several related and similar terms in the emergency medical field that are often confused and worth defining. EMS refers to the general field. There are also several terms for the individuals working in the EMS field: EMTs hold entry-level positions that require the least amount of training (UCLA Center for Prehospital Care, 2018). In California, EMTs must complete a course that ranges from 120 to 150 hours. EMTs receive training in skills such as CPR, providing oxygen, or administering glucose, but their training does not involve any treatments requiring breaking the skin (with very few exceptions). A paramedic requires significantly more training than an EMT; the courses for a paramedic range from 1,200 to 1,800 hours. Training includes topics such as anatomy, physiology, medication, and medical procedures. Paramedics learn the same skills as EMTs, but also learn skills such as starting intravenous lines, advanced airway management, and resuscitating and supporting patients experiencing health conditions such as heart attacks and trauma. Some states and provinces have additional levels of certification in between an EMT and a paramedic; these are often referred to as EMT-Intermediate. The entry-level EMT position is also sometimes referred to as EMT-1. It is worth noting that there are variations on these terms used throughout the United States and Canada, and they are not always used consistently.

EMS agencies operate with different purposes; not all provide mobile services or respond to 911 calls (Federal Interagency Committee on Emergency Medical Services, 2011). For example, Table 15 illustrates the distribution of the services provided by agencies across the United States. As a note, emergency medical dispatch centers do not provide EMS transportation, but provide

services online instead. Specialty care transport provides emergency transport between healthcare facilities.

**Table 15. EMS Agency Types and Response Roles**

| EMS Agency Types | Number | Percent |
|---|---|---|
| 911 response with transport | 12,575 | 60 |
| 911 response without transport | 5,529 | 26 |
| Non-emergency medical transport | 959 | 5 |
| Specialty care ground transport | 411 | 2 |
| Specialty care air transport | 319 | 2 |
| Emergency medical dispatch center | 1,074 | 5 |
| **Total** | **20,877** | **100** |

The most common form of contact between EMS and roadway users is medical transportation, accounting for 76% of all EMS responses (Federal Interagency Committee on Emergency Medical Services, 2011). This type of transportation includes 911 responses to scenes as well as non-emergency services, such as transporting patients between hospitals or nursing homes.

### 4.4.1 Medical Transportation

Patients are medically transported both from crash scenes and between hospitals. In an emergency setting, patients are generally taken to the nearest appropriately equipped hospital (e.g., major trauma, burns), or if circumstances allow, one agreed upon by the EMS provider and the patient. Non-emergency transportation, such as patient transfer between hospitals or to nursing homes, can be prearranged (Gunderson, 2015).

EMS personnel seem to have very limited or no interaction with vehicles (Gunderson, 2015; Hallinan, 2015; Shelby County Emergency Medical Services, 2012). The literature on EMS procedures indicates a strong focus on the patient: treatment for a patient before EMS arrives, transportation for EMS to get to the patient, assessing and treating a patient on site, and transporting the patient from the site to a healthcare facility. EMS personnel appear to rely primarily on fire or police services to address the vehicle involved in the incident and to extricate the patient, although in some cases EMS personnel may aid in extraction. Chapter 5: DO Needs Assessment Findings

The following discussion summarizes the findings from the focus group and one-on-one interview analysis. First, a summary of the focus group and one-on-one interview participants is presented. Next, findings for each operational scenario will be reviewed.

## 5.1 Participant Summary

### 5.1.1 Focus Groups

A focus group was considered filled when five participants were scheduled; however, it could be conducted with a minimum of two scheduled participants. Further, due to the unpredictable nature of emergency calls, not every focus group was filled. When other officers did not join the Web meeting within a 10-minute time window of their scheduled focus group, the team sometimes opted to interview participants one-on-one as opposed to rescheduling. This helped to avert the potential of losing participants who would not be available to reschedule, or unwilling due to frustration.

When possible, participants were paired in focus groups with those of similar rankings, years of experience, and department size. Furthermore, they were placed into focus groups of the same mode and jurisdiction. For EMS public safety officers, there was one group of volunteer department officers and one group of paid departments. Firefighter officers included two groups, one volunteer/combined with EMS, and the other a paid department. Law enforcement was divided into groups of state, county, and city demographics and then further balanced by population density. Table 16 shows the number of participants and average years of experience within each focus group.

**Table 16. Focus Group Participation Summary**

| Focus Group | Domain | Jurisdiction/ Compensation | Population Classification | Number of Participants | Average Years of Experience |
|---|---|---|---|---|---|
| 1 | Police | State Police | NA | 2 | 23.8 |
| 2 | Police | State Police | NA | 3 | 10.2 |
| 3 | Police | State Police | NA | 3 | 22.0 |
| 4 | Police | State Police | NA | 4 | 17.3 |
| 5 | Police | State Police | NA | 3 | 17.6 |
| 6 | Police | County Sheriff | Populous | 2 | 28.5 |
| 7 | Police | County Sheriff | Populous | 2 | 21.0 |
| 8 | Police | County Police | Populous | 2 | 21.0 |
| 9 | Police | City Police | Rural | 2 | 25.5 |
| 10 | Police | City Police | Rural | 3 | 21.6 |
| 11 | Police | City Police | Urban | 3 | 20.0 |
| 12 | Police | City Police | Urban | 3 | 21.6 |
| 13 | Police | City Police | Urban | 2 | 29.0 |
| 14 | Police | Canada/RCMP | NA | 2 | 13.5 |
| 15 | Fire | Volunteer | Rural | 2 | 26.0 |
| 16 | Fire | Paid/Combined EMS | NA | 5 | 21.4 |
| 17 | Fire | Paid | NA | 2 | 8.0 |
| 18 | EMS | Volunteer | NA | 5 | 13.8 |
| 19 | EMS | Paid | NA | 2 | 19.0 |
| 20 | EMS | Paid | NA | 2 | 20.0 |

### 5.1.2 One-on-One Interviews

Similar to the focus groups, participants were recruited for one-on-one interviews based on their location and jurisdictions (Table 17). Recruitment criteria focused on the 24 identified states and associated jurisdictions, compensation type (paid versus volunteer), and population density. The biggest difference in the methodology was that interviewees answered each question on their own as opposed to answering alongside from one to four other participants.

**Table 17. One-on-One Interview Participation Summary**

| Interview | Domain | Jurisdiction/ Compensation | Population Classification | Years Of Experience |
|---|---|---|---|---|
| 1 | Police | State Police | NA | 30 |
| 2 | Police | State Police | NA | 13 |
| 3 | Police | State Police | NA | 25 |
| 4 | Police | State Police | NA | 3 |
| 5 | Police | State Police | NA | 17 |
| 6 | Police | County Sheriff | Rural | 22 |
| 7 | Police | County Sheriff | Rural | 19 |
| 8 | Police | County Sheriff | Populous | 29 |
| 9 | Police | County Sheriff | Populous | 17 |
| 10 | Police | City Police | Rural | 29 |
| 11 | Police | City Police | Urban | 6 |
| 12 | Police | City Police | Urban | 14 |
| 13 | Police | City Police | Urban | 14 |
| 14 | Police | City Police | Rural | 22 |
| 15 | Police | City Police | Urban | 15 |
| 16 | Police | City Police | Urban | 14 |
| 17 | Police | City Police | Urban | 17 |
| 18 | Police | Canada/RCMP | NA | 17 |
| 19 | Fire | Paid/Combined EMS | NA | 34 |
| 20 | Fire | Paid/Combined EMS | NA | 40 |
| 21 | Fire | Volunteer | Rural | 32 |
| 22 | EMS | Volunteer | NA | 25 |
| 23 | EMS | Paid | Urban | 20 |
| 24 | Police | County Sheriff | Rural | 22 |
| 25 | Police | County Sheriff | Rural | 28 |
| 26 | Police | County Sheriff | Populous | 21 |
| 27 | Police | City Police | Rural | 10 |
| 28 | Police | City Police | Rural | 11 |

## 5.2 Overview of DO-related Questions

The following sections detail the common responses provided by each domain (law enforcement, fire and rescue, and EMS) per each classification (population or compensation types). The questions that were posed to the participants are detailed below in Table 18.

**Table 18. ADS-Related Questions Regarding Scenario Operations and Vehicle Interactions**

| Number | Question |
|---|---|
| 1 | How might your interactions change if one of the vehicles involved in this scenario were equipped with automation in a driverless mode? |
| 2 | How might your interactions change if you were able to know, by whatever means are available at the time, that a vehicle involved in the scenario was equipped with automation in a driverless mode? |
| 3 | How might your interactions change if there were passengers in the vehicle while it was being operated in a driverless mode? *[not for Abandoned or Unattended Vehicle scenario]* |
| 4 | How might your interactions change if the vehicle was parked in a location that required its immediate removal? *[for Abandoned or Unattended Vehicle scenario only]* |

Each question and response interaction posed the opportunity for a follow-up question to inquire why a participant answered the question a certain way, to ask what they might do differently in those situations, and to learn at what point during an operation it would be best to learn a vehicle is in DO.

Participants often provided similar or overlapping answers to questions 1 and 2. As a result, they were considered together with the context they were provided in.

When answering the questions, most of the participants' responses were phrased as a question itself. For example, a law enforcement officer may respond, "How will the vehicle recognize me?" when answering about how traffic direction and control might change their interactions. In this case, this answer would be coded as, "Needs to know how vehicle will recognize public safety official."

Also, responses were binned by interaction type, direct, indirect, or informational, using the following definitions. A *direct* interaction must involve the contact of a public safety official with the vehicle, which includes touching the vehicle or using a piece of equipment that would come into contact with the vehicle. An *indirect* interaction involves any implementation or action that the vehicle or its driver must sense and respond to; examples include the use of lights and sirens, the placement of an emergency vehicle on scene, and the interpretation of signage or signaling by an official. Lastly, an *informational* interaction is qualified as any details, data, or cues that must be interpreted or sensed by a public safety official; such as the status of a vehicle, the testimony of a witness, the presence of a hazard, or an official's awareness of a vehicle's capabilities.

The following sections provide an overview of the identified interactions associated with each scenario. The final section provides a summary of cross-cutting interactions. These sections detail the responses provided when asked about how general operations and interactions with vehicles may change due to the introduction of ADS-equipped vehicles in DO.

## 5.3 Responding to an Incident

The Responding to an Incident scenario was presented to 58 different public safety officials involved in law enforcement, fire and rescue, and EMS. Of the 58 participants, 41 were law enforcement, 11 were EMS, and 6 were fire and rescue, as shown in Table 19.

**Table 19. Breakdown of Participants in Responding to an Incident Scenario**

| Domain and Category | Number of Participants in Scenario |
|---|---|
| State Police | 15 |
| Rural County Police | 3 |
| Populous County Police | 1 |
| Rural Town Police | 6 |
| Urban City Police | 13 |
| Canadian Law Enforcement | 3 |
| Paid Fire and Rescue | 3 |
| Volunteer Fire and Rescue | 3 |
| Paid EMS | 5 |
| Volunteer EMS | 6 |
| **Total** | **58** |

### 5.3.1 Interactions with ADS-equipped Vehicles in DO Associated with Responding to an Incident

#### *5.3.1.1 Direct Interactions*

Due to the nature of responding to an incident, there are no direct interactions, or operations that require a public safety official to physically come into contact with a general public-operated vehicle.

#### *5.3.1.2 Indirect Interactions*

Responses generally indicated that public safety officials were unsure how the vehicle would sense their presence and level of urgency while responding to an incident. In general, they wished to understand how an ADS-equipped vehicle in DO would sense an emergency vehicle and respond accordingly. The following quotes are reflective of participants' uncertainty with how the vehicle's technology may operate in terms of sensing emergency vehicles.

> Will they automatically move to the side of the road when they hear lights and sirens or sense lights and sirens? I don't know. Hopefully the car manufacturers are putting that in the vehicles.
>
> ***– Career EMS***

> This is where my lack of knowledge… would there be some type of system on this car to get its attention, that it's being approached by emergency vehicle? Like will it have some type of audio sensor that's looking for a picture or frequency or something along those lines?
>
> ***– State Law Enforcement***

General communication with a vehicle was also mentioned in one response. Aside from all vehicles responding a certain way, the response indicated that, in certain situations, it might be better for a vehicle to move out of the way differently than it was programmed to do. In this scenario, an emergency responder may want to influence how that vehicle reacted or where it would divert, if possible. As an example, a vehicle may move to the right to yield for the emergency vehicle but may subsequently block an entrance the emergency vehicle needs to access in the process.

In addition to sensing emergency vehicles responding to an incident, the ability for the ADS-equipped vehicles in DO to sense manual traffic signal changes was also mentioned. Traffic signals can be changed manually via public safety officials during traffic direction and control and they can also be changed by public safety officials from inside their vehicles if their vehicles are equipped to do so. These changes often disrupt the scripted light cycle, which may or may not be important for ADS-equipped vehicles. These different categories of responses to indirect interactions have been captured below by domain in Table 20. A jurisdictional breakdown of participant feedback for the ADS-related questions are in Appendix E: Jurisdictional Breakdown of ADS-related Participant Feedback.

**Table 20. ADS-related Indirect Interactions Associated with Responding to an Incident**

| Participant Feedback | Domain (Responses) |
|---|---|
| Identify emergency vehicles | LE (14), EMS (1) |
| Sense manual traffic signal changes | EMS (1) |
| Communicate with public safety officials | LE (1) |

Abbreviations: LE = law enforcement; FR = fire and rescue; EMS = emergency medical services

#### *5.3.1.3 Informational Interactions*

Of the three interaction types, informational interactions were the most prevalent for this scenario, with the primary focus on how ADS-equipped vehicles operating in DO would respond when they sensed any emergency vehicle (law enforcement, fire and rescue, or ambulance). As

responding to incidents makes up a large portion of the operations for public safety officials, the responses indicated that all vehicles around them should react in the same way. The ability to predict the behavior of vehicles as they navigate to a scene increases their safety and the safety of traffic surrounding them.

> Well I don't know a whole lot about these types of vehicles, other than, of course, everyone thinks they're coming, but we haven't encountered 'em where I am. I guess I would have a lot of the hesitation, if I can even identify one, as to the predictability; if it's going to react to my lights and sirens at all, gonna be slow to react and I would certainly be cautious as to—if it doesn't react in some way, is it going turn in front of me as I'm trying to pass or anything like that.
>
> ***– Urban City Law Enforcement***

> Well, unless you knew what that driverless vehicle, what its policies were… whether it's supposed to pull over to the right and stop, or if it's supposed to maintain its speed, and you should know all of that stuff prior to approaching that driverless vehicle. That will change your kind of risk assessment as you're passing that vehicle.
>
> ***– Canadian Law Enforcement***

> Yeah, the responding would definitely be the major concern for emergency service personnel. Because there's so many different laws. There's so many different habits. There's so many different ways of doing things throughout the country, that every state has its own way of doing things. Whether it be laws that require you to go left and right on a four lane highway to leave that center line open, or pulling to the right. For emergency personnel responding would be would be the big factor, on how to program it for your different styles of driving, your different state laws.
>
> ***– Rural City Law Enforcement***

The second most common response involving an informational interaction regarded the determination of whether a vehicle around them was being operated in DO. This response was solely made by law enforcement participants. The primary reason for wanting to identify if an ADS-equipped vehicle was being operated in DO was to be able to predict the behavior of that vehicle as they approached it. The following two law enforcement responses provide an adequate summation for the collection of responses provided by participants.

> It would be important to know that the vehicle that's being operated in a driverless mode, or is able to recognize that an emergency vehicle of some sort is approaching from whichever direction. It's all directions, depending on the geometry of some intersections. Now it needs to know- we have a police car coming, what lane am I in, do I move left to right, do I move far enough over just so that the police vehicle can part the sea as it were, or do I pull over and do I stop on either the shoulder or the median? It's important to know, and it's really difficult even with a vehicle that's being operated by a driver, what that vehicle is going to do, because people sometimes do silly things when they are faced with all the sudden there's lights and sirens behind them. I've seen them, they hit the brakes, they speed up, they change lanes the wrong way. Inexperience also has a lot to do with that. So, knowing that an autonomous vehicle would be able to properly react to the presence of an emergency vehicle. To me, that's why it would be important to know that there is one there.
>
> ***– Canadian Law Enforcement***

> Well, it would help to know because it might help me if I know that it's a driverless vehicle that it's automated-equipped, and I have an understanding of what the car's programmed and what it's supposed to do. I can anticipate and, kind of plan my approach and plan my response around it. But if I don't know that that's an automated car in front of me, I'm going to treat it like everybody else on the road and expect the unexpected, whereas an automated car that's programmed doesn't have the human factor in there, the unexpected, the emotional response, the surprise response, where all of a sudden they do what's completely unexpected. I'm going to probably give the automated car more credibility than a human driver because the computer's programmed to do what it's supposed to do.
>
> ***– Rural Town Law Enforcement***

Responses often ventured toward speculation of how other vehicles may be able to be identified as an ADS-equipped vehicle in DO. Speculations included the use of a light on the ADS-equipped vehicle, a sticker on its fender, or a placard somewhere on the vehicle to indicate that it is ADS-equipped and capable of DO.

In addition to identifying whether vehicles were ADS-equipped and in DO, law enforcement also expressed an interest in knowing if one or more of the vehicles at the incident scene possessed this technology and was in DO. Public safety officials also wanted to be able to know if the vehicle at a scene contained any occupants. In each case, the presence or absence of drivers and/or passengers might reduce the resources dispatched to the scene as they would assume there would be no injuries.

Once the ADS-equipped vehicles in DO sensed the approach of an emergency vehicle, responses indicated that public safety officials would also want confirmation that the ADS-equipped vehicle sensed them. A visual confirmation, for example, a light on the vehicle, was noted as providing an acknowledgment that the ADS-equipped vehicle understood the situation and intends to react appropriately. Currently, public safety officials rely on the feedback such as eye contact with a motorist, particularly when navigating intersections during an emergency response, to ensure that the motorist will yield. The responses related to informational interactions has been captured in Table 21.

**Table 21. ADS-related Informational Interactions Associated with Responding to an Incident**

| Participant Feedback | Domain (Responses) |
|---|---|
| Consistently respond to emergency vehicles | LE (25), EMS (4), FR (1) |
| Identify vehicle in DO | LE (11), FR (1), EMS (3) |
| Identify vehicle at scene (they are responding to) in DO | LE (4), EMS (4) |
| Determine if vehicle at scene (they are responding to) has occupants | LE (1), EMS (1) |
| Feedback emergency vehicle has been recognized | LE (1), EMS (1) |

### 5.3.2 When to Know a Vehicle is Equipped with Automation in DO

The scenario of responding to an incident forks into two scenarios when considering ADS-equipped vehicles: 1) the vehicle at the scene being responded to, and 2) the vehicles surrounding the emergency vehicle in response.

For vehicles at the scene that public safety officials are responding to, the general theme of participant responses centered on finding out if the vehicle is ADS-equipped and in DO as soon as possible while en route or at the scene. If the vehicle's capabilities and presence or absence of occupants are learned en route, the public safety officials called to the scene could adjust their risk assessment. A lack of occupants and injuries at the scene may result in a reduced sense of urgency, which could translate to a slower and safer response to the scene.

For vehicles surrounding the emergency vehicles as they navigate to a scene, responses indicated that a visual identifier would be the easiest and quickest means for public safety officials to be aware of those vehicles. The need to identify the ADS-equipped vehicles in DO by a visual indicator was associated with an ability to predict the behavior of these vehicles (e.g., all might be programmed to react in a similar manner in emergency scenarios).

Being able to identify the ADS-equipped vehicles at intersections during an emergency response was said to benefit the operation; again, this is due to the ability to predict how the vehicle might behave as opposed to an unpredictable human driver.

### 5.3.3 Interactions with ADS-equipped Vehicles in DO Associated with Responding to an Incident Involving Passengers

#### *5.3.3.1 ADS-related Indirect Interactions Associated with Responding to an Incident*

Many of the answers provided during this scenario pertained more to passengers inside a vehicle at the scene as opposed to passengers inside vehicles on the way to a scene during a response. These responses are reflected in the "Securing a Scene" analysis.

Participants (3 EMS, 1 LE) included the presence of passengers in their considerations of how a vehicle without a driver would impact their operations, as they often assumed a driverless vehicle would also have no occupants at all. Therefore, similar responses to previous questions were provided in terms of passenger presence (i.e., when responding to an incident where no passengers were involved, fewer resources would be dispatched and the response may be less urgent and more safe).

Two law enforcement officials indicated that it would be important to know if there were passengers in the vehicles around them as they were navigating to a scene; however, they were unable to articulate why that information would be important or how it might affect their operations.

## 5.4 Securing a Scene

The Securing a Scene scenario was presented to 37 law enforcement officials, 12 fire and rescue officials, and 11 EMS officials. Of the 60 total participants, 38 were focus group members and 22 were part of one-on-one interviews. This breakdown of participants in domain and category is show below in Table 22.

**Table 22. Breakdown of Participants for Securing a Scene Scenario**

| Domain and Category | Number of Participants in Scenario |
|---|---|
| State Police | 15 |
| Rural County Police | 3 |
| Populous County Police | 5 |
| Rural Town Police | 9 |
| Urban City Police | 5 |
| Paid Fire and Rescue | 9 |
| Volunteer Fire and Rescue | 3 |
| Paid EMS | 5 |
| Volunteer EMS | 3 |
| Combined Fire/EMS Departments | 2 |
| Canadian EMS | 1 |
| **Total** | **60** |

### 5.4.1 Interactions with ADS-equipped Vehicles in DO Associated with Securing a Scene

#### *5.4.1.1 Direct Interactions*

The overwhelming response relating to a direct interaction involved how to disable the vehicle at the scene of an incident. With safety in mind, the responses tended to reason that disabling the vehicle, sometimes referred to as paralyzing the vehicle, would prevent it from moving and potentially striking a first responder at the scene. The following quote summarizes this idea for many of the responses.

> I think for me or for my department I would want all of my personnel to ensure that they don't place themselves between a driverless mode vehicle and any inanimate object such as a fire engine that's parked on the roadway, a guard rail, a tree, or anything else until someone who's trained can verify that all the systems in that driverless vehicle have been disabled, so that we know that it's not gonna move and in that process also not allowing anyone else–bystanders or other responders–in moving people back out of any possible pathway if we could determine if this thing takes off where's it gonna go, keeping people out of that area until we are certain that it's been disabled to the point that it will not move on its own again. That would be a concern of mine.
>
> ***– Paid Fire and Rescue***

Most of the responses indicated that disabling the vehicle would be among the first things they would need to do at the scene. There were few speculations about how disabling the vehicle may be accomplished, but some responses mentioned the use of a key fob (1 EMS), cutting battery

cables (1 LE, 1 FR, 1 EMS), or requesting that an occupant familiar with how the vehicle operates disengage it (1 LE).

If the vehicle remained on the roadway after an incident and there were no injuries or fatalities, removing the vehicle from the roadway as soon as possible would be the next priority. Agencies and areas that allow the use of a push-bumper to come into contact with and push a vehicle from a roadway would use those bumpers to force the vehicle off the road. Otherwise, there is a need to know the best method for moving the vehicle or getting it to move from the roadway if it is damaged and/or does not possess any controls.

If the vehicle could not be disabled or moved effectively, then responses indicated that with the use of other vehicles or larger apparatuses (such as fire trucks), public safety officials would attempt to barricade or block the vehicle in place to prevent it from moving and from other vehicles striking it (3 LE, 1 FR).

Fire and rescue teams, even if not stabilizing or extricating a vehicle, may still need to access the interior to check the vehicle for potential hazards in the cabin or trunk. A response from a fire and rescue official indicated the need to know how to access the interior of a vehicle involved in the incident (Table 23).

**Table 23. ADS-related Direct Interactions Associated with Securing a Scene**

| Participant Feedback | Domain (Responses) |
|---|---|
| Disable the vehicle | LE (30), FR (15), EMS (4) |
| Move vehicle from roadway | LE (10) |
| Access vehicle interior | FR (1) |

#### *5.4.1.2 Indirect Interactions*

Indirect interactions were particularly focused on how an ADS-equipped vehicle in DO would navigate a scene around an incident. Fire and rescue participants were particularly interested in how the scene needed to be set up. Responses from all three domains included whether additional markings or equipment such as transponders would be necessary for securing scenes.

As securing a scene requires traffic direction and control, some overlap in responses occurred. Responses indicated signaling passing vehicles where to go; thus, how to communicate directions to these vehicles was an important factor. This was mentioned even for vehicles that

were involved in the incident. For example, it was suggested that an ADS-equipped vehicle in DO could be signaled or somehow commanded to move to the shoulder (if still operable).

Securing a scene involves traffic management components such as temporary traffic signals and lane delineators. Responses indicated a curiosity as to whether the vehicles would be able to sense or detect temporary traffic signs and signals such as message boards, flaggers, flares, cones, or LEDs. As incident scenes are often chaotic, even with protocols in place, a response indicated the need for vehicles to be aware of when a public safety official proceeds to walk in front of it at a scene. This participant's specific scenario may be no different than a scenario of a civilian pedestrian crossing the path of the vehicle. Responses are captured below by domain in Table 24.

**Table 24. ADS-related Indirect Interactions Associated with Securing a Scene**

| Participant Feedback | Domain (Responses) |
|---|---|
| Secure a scene for vehicles to navigate | LE (3), FR (8), EMS (1) |
| Communicate advanced warnings to other vehicles | LE (4), FR (2) |
| Signal to vehicle to move or stop | LE (3), FR (2) |
| Sense temporary traffic signs and signals | FR (1), EMS (2) |
| Detect public safety officials standing in front of vehicle | EMS (1) |

In the event a crash has occurred, questions were posed as to whether the vehicles could communicate to each other that a roadway ahead was blocked or under delay, thus informing other vehicles to reroute and avoid the area, or whether public safety officials could transmit a signal to other vehicles with the same information as an advanced warning for traffic control around a scene. This same notion is mentioned in the Traffic Direction and Control scenario to follow. The following comment highlights this response more completely.

> If we know that a vehicle is approaching, depending on the vehicle's program – some I've actually studied through our crash investigation sections… if there was some kind of centralized database that we immediately notified, so all the driverless vehicles were aware of it on their approach or whether or not simply emergency lights were enough.
>
> ***– Populous County Law Enforcement***

#### *5.4.1.3 Informational Interactions*

The two most popular response themes for informational interactions when securing a scene were needing to know how to attribute the responsibility for an incident and how to extract pre-incident data from the vehicle. It can be assumed that, for general law enforcement investigative needs, the vehicle data that law enforcement would require would be just enough to analyze the scene and conduct an investigation of the incident. These two points are highlighted in the following comment.

> Our procedures would change, and having the ability to download the computer data, make sure we have the correct data to determine what happened and whose fault this was, because we can't interview the car.
>
> ***– State Law Enforcement***

Participant speculations about who might be attributed responsibility for a potential crash included a company that owned the vehicle, the manufacturer of the vehicle, someone controlling the vehicle, the vehicle's individual owner, or an occupant inside the vehicle. Other reasons for needing to know the owner specifically included making the owner aware of the situation and to begin an investigation as to why the incident occurred. The following two quotes encompass these speculations.

> I mean, if there's a collision, I'm not sure. You know, let's say the driverless car caused the crash, I'm not sure who would be responsible. Would it be the registered owner, would it be the vehicle manufacturer, would it be the technology manufacturer? I think these are all questions that still need to be answered.
>
> ***– Rural Town Law Enforcement***

> Well from our perspective if there's no driver in a vehicle and it violates a traffic law who are you handing that citation to? How are you going to deal with it? How? You know, obviously, we're not gonna be doing felony car stops on vehicles that don't have anybody in them so is it remote control? Is it a remote-controlled vehicle? Is there a driver sitting in a living room controlling it? Or did somebody just punch in 'go to Walmart and pick up my groceries and come back'?
>
> ***– Populous County Law Enforcement***

A vehicle registration certificate issued to the owner of any legal vehicle is typically placed in a glovebox inside the vehicle. This document establishes a link between a vehicle and the owner of the vehicle. In the event of a crash or traffic stop, a registration must be produced to law enforcement. Insurance information is also required, especially in the event of a crash. Without a human at the scene, a pair of law enforcement officials questioned how that information could be obtained.

> The only difference, obviously, you don't have any human contact in the vehicles. It challenges how to find out vehicle registration, proof of insurance. We probably need to get a phone number of somebody we need to contact to advise of the problem.
>
> ***– Rural Town Law Enforcement***

> Procedures would change greatly. It depends on if the automated vehicle was at fault for the collision or not. Two, we would have to verify the owner of the vehicle, the registration, the insurance and typically that's done through face-to-face communication and typically the drivers or the owners of the vehicle or whatever hand us that information. I'd be intrigued to know how I would get that information out of an automated vehicle.
>
> ***– Populous County Law Enforcement***

Procuring crash data from the vehicle to attribute responsibility or gain insight into contributing factors was a common topic. Discussions about the method for obtaining the data directly from the vehicle included remote communications with the vehicle. One participant expressed that they would not want non-law enforcement to have any ability to alter the data. Participants did not speculate about other methods of obtaining data, but they did mention legal procedures for

obtaining the rights to the data. Five responses indicated a search warrant may be required to access a vehicle's data. The following response goes into some detail about why a search warrant may be necessary.

> Yeah, I'm sure there's gonna be some type of search warrant. Because now, I've been on accident reconstruction probably back in like '94, I guess. And now that every car has this module that we want to download, that at least in the state of STATE, our attorney general says we need a search warrant to download every one of those. So, I can only imagine that as technology goes forward, I can only imagine that somebody is gonna have a reasonable expectation of privacy to that information. So, we're going to have to have, I'm saying we're going to have to have some type of search warrant to obtain that info.
>
> ***– State Law Enforcement***

Knowing how to identify a vehicle as being an ADS-equipped vehicle being operated in DO or capable of being operated in DO was mentioned as a way to assist law enforcement in what to expect when approaching the vehicle at a scene. Other responses, such as needing to know how the ADS-equipped vehicle would react to the presence of a public safety official, slightly overlap with this response. These needs stem from a lack of familiarity with the vehicles and an inability to speculate completely about how the vehicles may behave.

> Yeah, who's responsible for the vehicle? How do you identify that it's an autonomous vehicle, especially as you're approaching, you're thinking "is somebody hiding from me, or what?" I think maybe having some identifier on the vehicle.
>
> ***– Populous County Law Enforcement***

Feedback from the ADS-equipped vehicle that it recognizes the presence of a first responder or understands a command could increase comfort. A pair of responses indicated that eye contact with a vehicle operator as a means of understanding the intentions of a driver would be absent with an ADS-equipped vehicle in DO.

One participant also indicated that the post-crash behavior of an ADS-equipped vehicle could be less predictable that a non-ADS equipped vehicle due to the damage it may receive in an incident. Given that an ADS-equipped vehicle at a scene was involved in some type of crash but may otherwise appear to be operable, a pair of responses mentioned the need to know that it was

safe to continue operation. One of those responses speculated that the ADS-equipped vehicle could perform a diagnostic check that could inform law enforcement whether or not it was safe to operate.

> And then, how do we determine if that vehicle's going to be safe to be driven off? Or can the autonomous vehicle, is it going to have the ability to do its own diagnostic check? To determine whether or not it's safe, or do we not give it the ability to do that without having a person go through the vehicle to make sure it's safe after it's been involved in a crash.
>
> ***– State Law Enforcement***

Identifying an ADS-equipped vehicle with the capability of DO could assist public safety officials to anticipate reactions and behaviors, but responses also indicated public safety officials would like to know if there were occupants present prior to an incident. Currently, a large part of any incident scene operation is accounting for any occupants who may have been involved and possibly ejected out of a vehicle. Several responses mentioned that first responders currently already know there is at least one occupant per vehicle but that could change with the introduction of ADS-equipped vehicles in DO.

> Well, the first thing I would want to know is, is it actually an autonomous vehicle? Is it going to be marked as an autonomous vehicle? How do you know that it's an autonomous vehicle? And what level is that vehicle being operated in? So, how do we know that it's not like a level 4, and there's somebody that's in the vehicle and they get ejected out? But, we don't know.
>
> ***– Urban City Law Enforcement***

While the questions were scripted to pertain specifically to ADS-equipped vehicles in DO and not ADS-equipped vehicles requiring fallback-ready human drivers, a response did indicate a need to know how to differentiate between the two primarily for investigation purposes. In this scenario, law enforcement would want to know the mode the ADS-equipped vehicle was being operated in the moments leading up to an incident.

Some speculation as to how an ADS-equipped vehicle in DO could be identified typically included the use of placards on the vehicle that would make it immediately apparent that the vehicle was an ADS-equipped vehicle in DO.

Disabling the vehicle was binned as a direct interaction as the action of disabling the vehicle would likely, or could potentially, involve a physical interaction between a human and the vehicle. The determination of the vehicle's power source was binned as an informational interaction because the determination of how a vehicle is powered, whether by fuel, battery, or some other source, would inform public safety officials on how to disable or engage the vehicle. How the vehicle is powered also informs first responders of unique hazards associated with the vehicle, similar to how electrical or hybrid vehicles present specific considerations for cutting or manipulating during extrication. The following response indicates how the need to know how the vehicles are powered correlates with how potential hazards associated with the vehicle may be approached.

> I think if it was a crash or something of that nature, I think you would handle it the same way, but I think you need to consider a few things. These types of vehicles are highly uncommon. We need to get it shut down safely. If it's a fully electronic vehicle with certain types of batteries—I was in the safety industry previous to being employed as a trooper, I believe a lot of those types of vehicles are equipped with high powered lithium-type batteries—they're highly flammable—those would be my concerns.
>
> ***– State Law Enforcement***

Three responses speculated how an ADS-equipped vehicle may benefit the operation. One response believed the technology may have the ability to provide GPS coordinates to dispatch when involved in an incident. Knowing the area and specific location in advance could allow for an appropriate response to the scene and advanced knowledge of how the scene may need to be secured. Additionally, for vehicles in a queue at a scene that are ADS-equipped and empty, one EMS response pondered whether those vehicles could be used as medical transport for patients considered "walking wounded" and not in need of immediate attention. As the ADS-equipped vehicles were already staged on scene, the response indicated this could be a convenience for EMS response. This response, and others in regard to informational interactions associated with securing a scene, are captured below in Table 25.

**Table 25. ADS-related Informational Interactions Associated with Securing a Scene**

| Participant Feedback | Domain (Responses) |
|---|---|
| Extract pre-incident data from vehicle | LE (27) |
| Attribute responsibility of incident | LE (22) |
| Determine how vehicle is powered | LE (6), FR (5), EMS (1) |
| Determine if vehicle contained occupants | LE (10), EMS (1) |
| Identify who to contact | LE (9) |
| Identify vehicle in DO | LE (7) |
| Identify vehicle owner | LE (4), EMS (1) |
| Detect hazards unique to the vehicle | LE (4) |
| Anticipate how vehicle will respond when approached | LE (4) |
| Exchange documentation (e.g. license, registration, insurance card, and citation) | LE (3) |
| Determine vehicle is safe to resume travel after incident | LE (2) |
| Feedback that vehicle correctly interpreted commands or direction | LE (2) |
| Provides exact location of incident | LE (2) |
| Determine mode the vehicle was in prior to and during incident | LE (1) |
| If vehicle data can be remotely accessed or altered | LE (1) |
| If nearby ADS-equipped vehicles can be used for medical transport | EMS (1) |

### 5.4.2 When to Know a Vehicle is Equipped with Automation in DO

The spectrum of responses for when to know a vehicle is equipped with automation in DO were "on scene," "as soon as possible," or "immediately."

Responses that indicated knowing "on scene" (LE 5, FR 2) would be a benefit suspected that the ADS-equipped vehicle would be visually distinguishable from other vehicles. By recognizing the vehicle type and using the training they presumed they would have by that time, responses indicated that this would allow them to know in advance how to disable the vehicle, access the interior, and be aware of potential hazards unique to the vehicle.

Responses of "as soon as possible" or "immediately" (LE 13, FR 1, EMS 1) indicated public safety officials wanted to know before they arrived on scene. Speculations included the ability to contact the vehicle's owner and collecting data from the vehicle remotely to begin the investigation. Specific types of data and information to retrieve from the ADS-equipped vehicle included registration and contact information. Types of data were not specified aside from a confirmation of the ADS-equipped vehicle's operational mode at the time of the incident. In general, advanced knowledge of the vehicle's capabilities seemed to benefit investigative purposes as well as tip first responders as to the type of response they would need. Any malfunction the ADS-equipped vehicle was having or had prior to the incident would inform them how it needed to be treated on scene. It was assumed an ADS-equipped vehicle without

occupants would not warrant an urgent response in most cases. Reasons given by participants for immediate awareness of an ADS-equipped vehicle in DO are captured below in Table 26.

**Table 26. ADS-related Reasons for Immediate Awareness**

| Reason | Domain (Responses) |
|---|---|
| Determine if vehicle had any occupants | LE (5) |
| Determine who to contact regarding the vehicle | LE (2) |
| Collect data for investigation | LE (2) |
| Attribute responsibility | LE (3) |
| Identify if vehicle malfunctioned or is malfunctioning | LE (2) |
| Disable the vehicle | LE (4), FR (1) |
| Access vehicle interior | LE (1) |

It is believed that some participants may have confused the term "driverless" with having no occupants at all. Knowing either in advance or on scene that an ADS-equipped vehicle did not possess occupants would inform the allocation of resources. The following quotation offers one such example of the likely confusion between "driverless" and possessing no occupants; however, the point remains: knowing if occupants are present or not is critical to determining whether or not a search is needed.

> As soon as you pull up. I think it would be very helpful and pertinent to know that when you walk up to a vehicle and there's nobody in there - that we're not having to do a search for the victims or somebody that may have been thrown out. So, to know by either a sign, looking, somehow-another that we can see as we approach the vehicle that it's an automated vehicle.
>
> ***– Career Fire and Rescue***

### 5.4.3 Interactions with ADS-equipped Vehicles in DO Associated with Securing a Scene involving Passengers

*5.4.3.1 ADS-related Direct Interactions Associated with Passengers when Securing a Scene*

Having an acute sense of patient care, EMS as well as fire and rescue participants reiterated the need to know how to disable the ADS-equipped vehicle if passengers, or victims of an incident, were inside a vehicle at a scene. Disabling the vehicle includes de-energizing and ensuring the vehicle will not move while first responders tend to those inside. The frequency of this response by domain is captured in Table 27 below.

> I would want to secure the vehicle, to make sure that it can't move on me. Just as I would with any other vehicle, just using whatever techniques I have to, for the fact that it's automated, before you start trying to do much with the patients. 'Cause you don't want to either further hurt them or the responders because the vehicle can move.
>
> ***– Volunteer Fire and Rescue***

It was previously mentioned that, when securing a scene, first responders seek to disable vehicles regardless of passengers, and it appears that the presence of passengers heightens this task as more of a priority once on scene.

**Table 27. ADS-related Direct Interactions Associated with Passengers when Securing a Scene**

| Participant Feedback | Domain (Responses) |
|---|---|
| Disable the vehicle | LE (1), FR (3), EMS (1) |

#### *5.4.3.2 Indirect Interactions*

Information regarding the number of occupants in an ADS-equipped vehicle involved at a scene was binned as informational, while the act of searching for occupants was binned as an indirect interaction. This was because the act of searching for occupants requires a visual search of the vehicle and the area around the vehicle. Again, if an ADS-equipped vehicle contained no occupants prior to an incident, public safety officials wished to know that prior to reaching the scene or immediately on scene. The frequency of this response for indirect interactions by domain is captured in Table 28 below.

> Again, that's huge. We try to account for all the occupants of a vehicle. For instance, possible ejection. We need to know who was in what vehicle and what position. I've been on scenes where the driver, the occupants are seriously hurt and they can't really answer the questions, so we assume the worst as far as possible occupants of the vehicle. So, we may go look in a field or the ditch, to see if there's somebody lying there because… I was just reading a news story yesterday about a motorcycle and driver who was found days after he had wrecked into the ditch, and that happens with passenger cars, too, they go off the road and people can't see the wreckage from the road and it's not a good ending.
>
> ***– Volunteer EMS***

**Table 28. ADS-related Indirect Interactions Associated with Passengers when Securing a Scene**

| Participant Feedback | Domain (Responses) |
|---|---|
| Determine if search for occupants is necessary | LE (2), EMS (2) |

#### *5.4.3.3 Informational Interactions*

A majority of responses, all from law enforcement, indicated that passengers are a good source of information as they can provide eyewitness accounts of a crash. In the event an empty ADS-equipped vehicle in DO is involved in an incident or two such vehicles are involved, there would potentially be no witnesses to get an account from. In the event passengers were present, law enforcement would question those passengers as a part of their investigation.

> They'd also be witnesses if they weren't a driver. They'd have to be interviewed to see what happened and what went wrong, and if it was the other driver's fault; or if it was the automated vehicle's fault or how the crash had happened.
>
> ***– Urban City Law Enforcement***

> Well, the main difference would be, number one, check on the passengers just to make sure they're not injured. Number two, we'd be able to collect their statement as far as how the collision occurred.
>
> ***– Rural Town Law Enforcement***

The investigation procedures ties into the completion of an accident report where law enforcement will combine observable features of an incident with witness accounts to attribute responsibility or fault. Oftentimes, the information required varies from state-to-state, but some of the information mentioned in responses included the identities of occupants, where they were seated, and if they were injured.

The second most common response theme involved checking for and treating potentially injured passengers. While this was the second most common response, it was typically regarded as a higher priority on scene.

> Yeah, that's definitely going to change things because you've got potential people that are hurt. The car I think of is like a robot. I'm going to download information out of it somehow, I assume. But people, that human factor, if they're hurt… they're potential witnesses or they are witnesses to what happened as well. They've got to be treated that way.
>
> ***– Rural County Law Enforcement***

Additional information, such as the number of occupants in the ADS-equipped vehicle prior to the incident would inform first responders of how many they needed to search for. Currently, as was previously mentioned, on an incident scene today, all first responders can be sure there is at least one occupant per vehicle and, if that occupant is unresponsive, they then look for clues inside the vehicle or around the vehicle to determine if other occupants were ejected. In the event of an ADS-equipped vehicle in DO being involved in a crash, the number of passengers can be zero or higher and those occupants could be seated in non-traditional locations within the vehicle. For example, instead of there always being at least one occupant in the driver's seat for current vehicles, a lone passenger may be seated in the rear.

> Yeah, and those roll over and ejection scenarios where now, like NAME said, we know there's at least one driver, but out in our rural areas that we do reach, we've had times that it's taken our rescue squad members and county law enforcement up to half an hour to locate one patient and they knew where the vehicle left the road and where the vehicle ended and it still took them time to search a cornfield for a person. So definitely, it would be nice to know how many people we're looking for.
>
> ***– Volunteer EMS***

The notion of responsibility was once again mentioned when considering how passengers may influence the operations. Three of the five responses quote existent laws as they currently apply to conventional vehicles as they were understood by the participants. These laws essentially stated that for current vehicle models, a licensed driver behind the steering wheel can be attributed responsibility for a crash. These same participants used these laws to justify their speculation that any occupant seated in that position of an ADS-equipped vehicle in DO could be treated similarly.

Once again, participants often leapt from ADS-equipped vehicles in DO to those that may also include a fallback-ready user. Four responses from law enforcement officials wanted to know how they could determine the "mode" a vehicle was in prior to an incident for investigative purposes. For the ADS-equipped vehicles in DO, they wanted to know if those vehicles could be manipulated remotely or by someone in the vehicle. These responses are captured by domain in Table 29 below.

> If there's an actual person behind the wheel that would be able to take the vehicle back over should the system fail - or should you need to get into a place where it can go fully autonomous because of infrastructure or whatever the scenario may be- if there's a person sitting in the seat, then I'm going to wonder who that person is. Because they may be culpable for some of the reactions, or especially if that vehicle happens to be at fault. But if it was just people sitting? For example, it was a taxi or TAXI COMPANY or one of these other things and people were just sitting in the back, I'd be very interested in what they had to say as far as their statement would be. But as far as them being in there, at that point, they're just gonna be a good witness for you. That's the best you can expect from them, I would think.
>
> ***– State Law Enforcement***

**Table 29. ADS-related Informational Interactions Associated with Passengers when Securing a Scene**

| Participant Feedback | Domain (Responses) |
|---|---|
| Request statements and accounts from passengers regarding incident | LE (25) |
| Determine if any passengers in the vehicle are injured | LE (12), FR (1), EMS (3) |
| Determine number of occupants in the vehicle prior to incident | LE (6), EMS (6) |
| Complete accident report | LE (6) |
| Determine if passengers could manipulate the actions of the vehicle prior to crash | LE (6) |
| Identify if a passenger is responsible for incident | LE (5) |
| Classify mode the vehicle was in prior to incident | LE (4) |

## 5.5 Traffic Direction and Control

The Traffic Direction and Control scenario was presented to 55 total participants: 35 law enforcement officers, 9 fire and rescue officials, and 11 EMS personnel as shown below in Table 30.

**Table 30. Breakdown of Participants for Traffic Direction and Control Scenario**

| Domain and Category | Number of Participants in Scenario |
|---|---|
| State Police | 12 |
| Rural County Police | 4 |
| Populous County Police | 5 |
| Rural Town Police | 1 |
| Urban City Police | 10 |
| Canadian Police | 3 |
| Paid Fire and Rescue | 6 |
| Volunteer Fire and Rescue | 3 |
| Paid EMS | 5 |
| Volunteer EMS | 3 |
| Combined Fire/EMS Departments | 2 |
| Canadian EMS | 1 |
| **Total** | **55** |

### 5.5.1 Interactions with ADS-equipped Vehicles in DO Associated with Traffic Direction and Control

#### *5.5.1.1 Direct Interactions*

The operation of conducting traffic direction and control rarely requires public safety officials to come in contact with a vehicle or performing a direct interaction. No mentions of a direct interaction were made in the responses to questions regarding ADS-equipped vehicles in DO.

#### *5.5.1.2 Indirect Interactions*

The key component to traffic direction and control involves public safety officials giving physical or audible commands to motorists on where to navigate. This largely involves the use of eye contact to communicate intentions as well as receive feedback that a motorist has acknowledged the command given. The bulk of responses regarding traffic direction and control centered on how public safety officials are to communicate, or signal, vehicles on when and where to stop and go.

> I agree with what was just said. In the first scenario, with making eye contact with the driver, making sure that the driver is aware that you're there and getting the driver to do what you want it to do - if there's no driver in the vehicle, I'm not sure how that message is going to be conveyed to a car that does not have a driver.
>
> ***– State Law Enforcement***

Responses indicated that the participants had a difficult time fathoming how their current procedures of using hand signals, flashlights, and whistles would convey the same meaning to an ADS-equipped vehicle in DO. Some responses speculated that special training for more universal and proper signaling may be warranted. Others posed that other technology may come into play, whether it was to broadcast a signal to vehicles or the use of special equipment, perhaps with infrared capabilities, to communicate with vehicles. Participants also speculated the advent of garments that may interact with an ADS-equipped vehicle. The following two quotes summarize a majority of the responses regarding specialized equipment or procedures for communicating during a traffic control operation.

> You have to have something in place to make sure that that vehicle is able to be driven in a manner that - if I'm just doing traffic control through a scene and I want that vehicle to slow down, move to the left, move to the right, there has to be something in place for that vehicle to be able to follow direction from me or the person doing traffic control. Be it being able to recognize a standard hand signal, see lane markings, or lane-change markings, such as cones or flares, E-flares. The process would have to change. There's no way to say I would just do the same thing all the time.
>
> ***– Canadian Law Enforcement***

> That’s just that side of that piece, then the scene management, as far as there's more automated driverless vehicles coming through. How as an officer am I supposed to manage that with my hands? Are there some kind of new whistles are gloves or something that's gonna come out that's gonna allow me to control those vehicles coming through my scene so that that stops when I asked it to stop and goes to the other lane when I ask it? Do we have to buy new cones? Do we have to get new flares? What does that mean? How's that look? And who's going to pay for that?
>
> ***– Populous County Law Enforcement***

It is worth noting that many of the responses indicated that should the ADS-equipped vehicles work as intended, then the safety of conducting traffic direction and control could be augmented. It was speculated that the vehicles would respond more appropriately to warning signs and be safer than a driver who may be intoxicated or distracted.

> One way that it could benefit—computers sometimes the way they are designed, they see things as black and white—so if there's a warning up ahead, they're gonna heed that warning and slow down and hopefully take the appropriate safety precautions. Whereas the human driver, you'll see - and we see it all the time, I may even be guilty of it myself—where you're driving down the road, you see signs for construction ahead and then you keep going. There's no construction, and so you just keep kinda going through your normal course of business or drive as you normally have until you kinda come up on it and see more signs of construction or something up ahead. Whereas you know that you're probably gonna get that from that autonomous vehicle, if the warning's there, every time, regardless of whether it's necessary or not.
>
> ***– Urban City Law Enforcement***

Prior to giving any commands or directions to a vehicle in a queue, public safety officials rely on the driver to visualize and recognize them first and then react appropriately. Similarly, in the case of ADS-equipped vehicles in DO, responses indicated that the vehicles would need to recognize the presence of someone conducting traffic direction and control.

> Or is it going to be able to detect a police officer signaling traffic, to go around an obstacle, or a hazard, or in intersections where there's a crash. Or is it going to confuse it? Is the autonomous vehicle going to stop right there not move?
>
> ***– State Law Enforcement***

An additional response pointed out that the ADS-equipped vehicle may need to distinguish someone conducting traffic direction and control from another pedestrian.

> So, I think this would be the most difficult part of the whole deal. One of the most important parts of directing traffic is eye contact. And if you don't have a driver, then there's no way to get any kind of eye contact. A lot of times, it's stepping out in front of vehicles and getting them to stop by making contact by doing hand controls and things like that. I guess it would be depending on the level of automation and how it accurate was. Whether it would be able to recognize an officer standing in front of them that would make them stop, or if it was another pedestrian in front of them. But there's oftentimes that we have to stop traffic for an emergency vehicle going through or something like that. The fact that a vehicle's being automated would be pretty significant in my opinion.
>
> ***– Urban City Law Enforcement***

To reduce the number of vehicles they may need to interact with or to warn approaching vehicles to proceed with caution, a number of responses speculated that the use of a mass signal, either produced by the vehicles themselves or broadcast by a public safety entity, could benefit the operation. A response indicated that an advanced warning signal to surrounding vehicles could benefit traffic flow around a scene before responders arrived to control it.

> I feel like at that point, rather than sitting a sign a quarter of a mile down the road, maybe our fire trucks are going to be equipped, or even just dispatch is going to send something out to your GPS in your car that there's an accident ahead of you, warning the vehicle if it's going to have to stop or go to the right or left lane, whichever. I could see the technology aiding in, I mean, again, if it came from dispatch, I could see traffic already flowing before the fire trucks were even on scene. If there was a way to communicate that way.
>
> ***– Volunteer Fire and Rescue***

In addition to public safety officials standing in a roadway conducting traffic control, the operation also consists of temporary signage, cones, flares, message boards, and occasionally at intersections, just flashing caution lights. Participants indicated they would need to know that the vehicles could detect the presence as well as comprehend the meaning of those devices. On high-speed roadways or during inclement weather, traffic control is performed with as few people as possible and instead detour signage and advanced warning equipment are used. The following response indicates a need to know how an ADS-equipped vehicle in DO would behave in sensing or detecting the advanced warnings.

> Yes, so if we change the traffic signals and it goes to blinking yellow, what's it gonna do to that? If we have to put up detour signage, how does it react a detour signage? Does it—do we have to put things on the roadway in order for them to react to all these things? If it's bad inclement weather, because we're cops, we don't understand how this technology works, so how are we supposed to get this technology to communicate with what we're trying to get the traffic to do?
>
> ***– Populous County Law Enforcement***

There are times when vehicles must be routed via unintuitive pathways, such as the wrong way of a one-way street or making a normally prohibited U-turn. On two-lane roadways, traffic may

need to be directed across the center line and down the opposing direction of travel or across the edge line and along the shoulder of a roadway. Responses suggested that public safety officials would need to know the capabilities and behaviors of ADS-equipped vehicles regarding those situations when conducting traffic control.

> And then I think the other thing, like I talked about a little bit before, how do you give direction to one of those types of vehicles that they need to move on the shoulder or they may go somewhere that not a quote-unquote "road" and will have to take a detour somehow or go across a median?
>
> ***– Career Fire and Rescue***

In the event advanced warnings are not available due to how soon after an incident a vehicle approaches or due to a lack of resources in a specific area, responses also indicated a need for the vehicles to respond appropriately to slowing traffic. In that scenario, slowing traffic becomes an advanced warning. This response, among others, are captured in Table 31.

**Table 31. ADS-related Indirect Interactions Associated with Traffic Direction and Control**

| Participant Feedback | Domain (Responses) |
|---|---|
| Signal directions to vehicles | LE (31), FR (1), EMS (6) |
| Communicate with surrounding vehicles | LE (6), FR (4), EMS (4) |
| Sense temporary traffic control devices | LE (8), FR (1), EMS (1) |
| Sense public safety officials and distinguish them from pedestrians | LE (7), EMS (2) |
| Direct to violate highway rules | LE (2), FR (2) |
| Recognize and respond to slowing traffic | LE (1), FR (2) |

#### *5.5.1.3 Informational Interactions*

The theme of needing to know the ADS-equipped vehicle will respond to a temporary traffic device or to a public safety official signaling traffic was binned as an indirect interaction, as those devices and officials are indirectly providing information to the ADS-equipped vehicle. The need to know, informationally, how an ADS-equipped vehicle will behave and react to traffic control as a means of predicting its behavior was binned as an informational interaction.

Several responses across all domains indicated a need to know how an ADS-equipped vehicle in DO may respond and behave to traffic control, as show below in Table 32. The speculations of how such a vehicle might respond ranged from the vehicle taking no action and continuing or the vehicle coming to a complete stop or "freezing."

> And that goes to another point to, if an autonomous vehicle is in a queue for a traffic crash and you have cones and everything set up, and you're routing that queue around the crash… scene, is that autonomous vehicle going to know how to go around that team if it doesn't have a driver?
>
> ***– State Law Enforcement***

Participants speculated on how they may be able to identify a vehicle is ADS-equipped in DO. Speculations included a lighted marquee, like a taxi, that would make it clear in advance as traffic controllers are typically focused on the immediate vehicles in a queue and may look ahead for larger vehicles they need to route specially. Having something that is noticeable from a distance would provide time to adjust or prepare for interacting with the vehicle.

A pair of county police noted that in their area there are rural sections where GPS capabilities are limited. In their responses, they indicated they would want to know that the vehicles could receive a detour command through an area where a GPS signal was less reliable.

One comment from an EMS official wondered about the distance a public safety official would need to be from an ADS-equipped vehicle for it to sense them and receive their commands.

> First of all, I think it helps protect the person directing traffic because the car should sense that they're there, and stop. The concern, I would have is I don't know what distance it would be between the personnel, the human being and the car. At what point will stop?
>
> ***– Career EMS***

**Table 32. ADS-related Informational Interactions Associated with Traffic Direction and Control**

| Participant Feedback | Domain (Responses) |
|---|---|
| Anticipate behavior and reaction to traffic control | LE (13), FR (1), EMS (5) |
| Identify an ADS-equipped vehicle in DO | LE (7), FR (5), EMS (2) |
| Receive feedback that the vehicle understood commands | LE (6), EMS (3) |
| Anticipate behavior in rural areas | LE (2) |
| Recognize distance vehicles can sense public safety officials | EMS (1) |

### 5.5.2 When to Know a Vehicle is Equipped with Automation in DO

Public safety officials (LE 10; EMS 1) indicated they would want to know a vehicle was ADS-equipped in DO as soon as possible. The task of traffic direction and control requires public

safety officials to be attentive to their surroundings and each vehicle in the queue. An indication that a vehicle was ADS-equipped and in DO would likely need to be easily visible. The following two quotes explain how quickly determining the ADS-equipped capabilities of the vehicle could potentially impact their confidence in conducting traffic control.

> I think, visually, if there was some sort of visual marker on the vehicle identifying the fact that it's a driverless vehicle would be great. Again, as you indicated I think in the first scenario, that traffic control person is looking for eye-to-eye contact in order for confirmation that his messages are being received by those approaching the incident. Lacking that, we certainly would wanna know that we have, don't have that ability for eye to eye contact with that vehicle which may cause us to watch it a little bit more closely.
>
> ***– Rural County Law Enforcement***

> I would think it would be most important to know prior to really you giving the command to stop or which direction to go. Ideally, if I was directing traffic, I would like to be able to see some kind of visual clue that it's a driverless motor vehicle.
>
> ***– Urban City Law Enforcement***

### 5.5.3 Interactions with ADS-equipped Vehicles in DO Associated with Traffic Direction and Control involving Passengers

It is not common for passengers inside a vehicle to impact the operations of traffic direction and control. Responses indicated that this would be the case for ADS-equipped vehicles in DO as well. Ten law enforcement, 3 fire and rescue, and 1 EMS official stated that passengers would have no impact on operations.

Other responses indicated participants wished to know if passengers could influence an ADS-equipped vehicle in DO. In the event that passengers could potentially influence the actions of the ADS-equipped vehicle, then passengers would matter to the operation. Otherwise, they would not.

> I think the only difference would be is if the passengers would be able to have some influence over that vehicle. If the vehicle is truly autonomous and doesn't have any steering or pedals, we could still get the attention of the operators, of the occupants, but I'm not sure they would be able to do anything to stop the vehicle to assist us.
>
> ***– State Law Enforcement***

Additionally, one participant conveyed a scenario that, although seemingly rare, should be taken into consideration. In the example, a rideshare vehicle may have passengers inside of it while being directed around an incident but the riders believe they are close enough to their destination that they decide to exit the vehicle, perhaps in an area where public safety officials do not wish them to. No potential resolution to that scenario was provided.

## 5.6 Traffic Stops and Checkpoints

The Traffic Stops and Checkpoints scenario was presented to 31 different law enforcement officers in different domains as shown in Table 33. Twenty of the participants were part of focus groups and 11 participated as individual interviews.

**Table 33. Breakdown of Participants for Traffic Stops and Checkpoints Scenario**

| Domain and Category | Number of Participants in Scenario |
|---|---|
| State Police | 8 |
| Rural County Police | 1 |
| Populous County Police | 9 |
| Rural Town Police | 2 |
| Urban City Police | 8 |
| Canadian Police | 3 |
| **Total** | **31** |

### 5.6.1 Interactions with ADS-equipped Vehicles in DO Associated with Traffic Stops and Checkpoints

#### *5.6.1.1 Direct Interactions*

Generally, there are very few potential direct interactions when conducting a traffic stop or checkpoint given that the operation is intended to be routine. Felony traffic stops or pursuits may require more intense actions from law enforcement relating to their interactions with a vehicle. Because the operations considered here are common traffic stops and checkpoints, there were no responses indicating that current direct interactions would be affected or that new direct interactions could be necessary.

#### *5.6.1.2 Indirect Interactions*

Many law enforcement responses (16) wondered how to initiate a stop with an ADS-equipped vehicle in DO. Responses speculated that the ADS-equipped vehicles could sense their police vehicles by detecting the lights and sirens. Most responses, shown in Table 34, indicated that their unfamiliarity with the technology and how it could work made it difficult for them to speculate how initiating a traffic stop could affect their current procedures.

One response was curious how a law enforcement officer could redirect an ADS-equipped vehicle that is pulled over for a traffic stop to move to a safer location if necessary. The following quote encapsulates the themes of the last two paragraphs.

> Well, first of all, is the autonomous vehicle going to be able to recognize a police vehicle? And it's going to be up to the vehicle to determine the place, where and how to pull over. So that could be an issue. And how do you talk to the car? And tell it to move to the right further? Because what if there's some type of obstruction on the side of the roadway that won't allow the autonomous vehicle to say, go into some weeds or whatever. It won't drive there. How do you get it to move over further?
>
> ***– State Law Enforcement***

In speculation, one participant indicated that the ability to control the ADS-equipped vehicle remotely could be beneficial. The following quote indicates why law enforcement may find a similar feature useful.

> So my issue with the driverless car is, I don't, you know I have nobody to interact with. I mean, if, I guess if I had a little remote control that could shut down any driverless car out there. That'd be great, that'd be fantastic. Nobody would ever run from me. (Chuckles) I mean that would be - It would be COMPANY safe. I would love that. So, if I'm at a checkpoint and the car comes up and I can just order it to stop with the push of a little remote control fob or something, maybe? Hey, that'd be great. But other than that, you're asking a member to stand in front of a moving vehicle and hoping that the sensor picks them up just to stop.
>
> ***– Law Enforcement, Canada***

**Table 34. ADS-related Indirect Interactions Associated with Traffic Stops and Checkpoints**

| Participant Feedback | Domain (Responses) |
|---|---|
| Signal vehicle to pull over and stop | LE (16) |
| Stop or direct vehicle to a safer location | LE (6) |
| Recognize traffic stop from emergency response | LE (3) |
| Remotely control vehicle to stop or slow | LE (1) |

#### *5.4.1.3 Informational Interactions*

The most common response relating to an informational interaction during a traffic stop or checkpoint operation centered on determining the person responsible for the ADS-equipped vehicle. Speculations regarding responsibility included anyone sitting in the traditional location of a driver's seat per current laws regarding ADS-equipped vehicles. If empty, it was speculated that the manufacturer, a specific rideshare company or taxi service, or the owner would be assigned responsibility. If an ADS-equipped vehicle were somehow controlled remotely, law enforcement would also want to know this.

The importance of assigning responsibility for a vehicle involved in an incident for law enforcement officials extends into the next common response for them, which regards citations. For a traffic stop to be official and recognized by the court, a citation or summons is created at the scene. Depending on the violation, this may require a court appearance or fine, and some states require a signature of the driver, the violator, prior to leaving the scene. In addition to determining who is responsible for the vehicle and its conduct leading to the traffic stop, law enforcement needs to know how the citation will be completed, delivered, and confirmed with a signature.

Assuming there is no one in the vehicle during the traffic stop, responses indicated a need to know who to communicate with during the operation. Some speculated that communication with an owner or operator would require a phone call, perhaps from dispatch, to that individual or company. The importance of this interaction stemmed not only from determining responsibility but to also gain insight into why the vehicle may have been behaving in a such a way to warrant a traffic stop. However, it was acknowledged in unrelated responses that traffic stops may not be related to something the vehicle did but may relate to outdated inspections, registrations, or a search for a specific occupant. By contacting the owner or the responsible party of the vehicle, law enforcement would be able to investigate the vehicle's situation further.

The following quotes speak to the first three themes.

> If we're stopping a vehicle for a violation—it's paramount to have that safe and effective communication with the operator. I'm not really sure. And if there's a traffic violation—the stop and the citation issuance or a verbal warning or whatever it is, it's all about holding people, or in this instance, the automated vehicle accountable for its actions. So if it was speeding, or not maintaining its lane or stuff like that, I don't know who you would hold accountable.
>
> ***– Law Enforcement of Populous County***

There were responses that assumed an ADS-equipped vehicle in DO would be less likely to violate the law and therefore be less likely to warrant a traffic stop. Responses did indicate that if an ADS-equipped vehicle did warrant a stop then it could imply that the ADS was malfunctioning. If the ADS was experiencing a malfunction, law enforcement, if possible, would want to be able to identify the malfunction. If identified, responses such as those from the Securing a Scene Scenario, indicated they may not want the vehicle to re-enter the roadway until those issues are repaired.

> I would say a majority of our stops are due to civil motor vehicle infractions, which is the responsibility of the operator. If it's a driverless motor vehicle, you almost wouldn't need to even stop it. You could just document it and report it to the owner or manufacturer, whoever's the responsible party of the vehicle. Typically stopping the car for the violation is to correct the infraction. But if it's driverless, us stopping and talking to the passenger won't correct the situation until the programmer can fix whatever the electronic issue is wrong with it.
>
> ***– Urban City Law Enforcement***

Having the ability to identify an ADS-equipped vehicle in DO or even vehicles with the capability of in DO would benefit law enforcement in their approach, according to responses. The responses were partially concerned with vehicles that may not be equipped with complete driverless automation; however, answers indicated that the ability to know that a human could have been responsible for a vehicle's actions prior to a traffic stop was important.

Being able to visually identify an ADS-equipped vehicle in DO was generally regarded as beneficial. Speculations included the use of lights or placards that could indicate to law

enforcement visually the capabilities of the vehicle's automation. Knowing an ADS-equipped vehicle was in DO would help law enforcement know what to expect from the vehicle in terms of behavior and, post-training, prepare them for how to interact with it.

It is common in many traffic stop conditions, depending on roadway type, traffic volume, weather, and roadway geometry, for law enforcement to wait until a safe location is available before initiating a traffic stop. Once a stop has been initiated, law enforcement hopes that the driver chooses a location safe for both the officer and the driver of the violating vehicle. In the case of ADS-equipped vehicles in DO, responses made clear that law enforcement would want feedback that the vehicle they are stopping intends to travel to a safe location to stop. In the event that the vehicle did not, the aforementioned indirect interaction of communicating with the vehicle regarding where to move to would follow.

Feedback as to whether the ADS-equipped vehicle in DO has received the message to stop and intends to do so was included in a response. Additionally, should it fail to stop, a response conveyed the need to know how a pursuit is to be conducted. Once an ADS-equipped vehicle pulls over and stops, two responses indicated a need to know it would remain stopped for the duration of the procedure and implied a need to know how to release the vehicle. Another response questioned whether the vehicle could be powered down during the procedure to ensure it stayed in place.

The ability to retrieve vehicle data would benefit law enforcement in determining the actions of the ADS-equipped vehicle prior to the traffic stop. In addition to determining the extent of a potential moving violation, the data may also assist in identifying a potential malfunction with the ADS. Law enforcement wondered if a warrant would be required to access the data.

Registration and insurance information are important components to most all traffic stops. Participants were curious how that information would be available without anyone in the vehicle to provide it, and what to do should none be available. All responses are captured in Table 35 below.

> That would be a fun interaction. You would just do the approach just to realize there's nobody inside the vehicle. There'd need to be a way for the driverless vehicle - for us to ascertain that all the paperwork in proper order. We usually require for driver's license, registration, and proof of insurance. If there's no driver, there's no driver's license. We still need to be able to verify the current registration, the proof of insurance. And in case of a citation, let's say the vehicle ran a red light, we need to be able to figure out a proper protocol for who we're going to cite here.
>
> ***– Rural Town Law Enforcement***

**Table 35. ADS-related Informational Interactions Associated with Traffic Stops and Checkpoints**

| Participant Feedback | Domain (Responses) |
|---|---|
| Determine who is responsible | LE (21) |
| Write the citation or warning | LE (13) |
| Recognize if operating or is capable of operating in DO | LE (11) |
| Identify who to communicate with during the traffic stop | LE (9) |
| Determine if vehicle is experiencing a malfunction | LE (9) |
| Retrieve vehicle data | LE (4) |
| Receive feedback that vehicle will stop in a safe location | LE (3) |
| Access vehicle registration and insurance information | LE (2) |
| Anticipate how quickly vehicle will react to traffic stop initiation | LE (2) |
| Receive feedback the vehicle intends to stop | LE (1) |
| Identify who may be controlling the vehicle | LE (1) |

### 5.6.2 When to Know a Vehicle is Equipped with Automation in DO

Eight responses indicated that knowing a vehicle was equipped with automation in DO would benefit the operation most prior to stopping it. During the period law enforcement is following the vehicle, assessing the number of occupants, running the license plate, or communicating the make and model to dispatch, they would also need to communicate the automated capabilities of the vehicle. Three other, vaguer responses indicated the need to know "as soon as possible," which could also mean "prior to stopping it."

Knowing the vehicle's automation status in advance of a traffic stop would help law enforcement anticipate how it will behave and react. Additionally, an escalation of response may not be required if the ADS-equipped vehicle fails to pull over. Although law enforcement officers were unable to speculate specifically on how their operations may precisely change regarding ADS-equipped vehicles, responses indicated that, based on their training of the time, the knowledge of

an ADS-equipped vehicles' capabilities would benefit them in terms of predicting the ADS's behavior.

### 5.6.3 Interactions with ADS-equipped Vehicles in DO Associated with Traffic Stops and Checkpoints involving Passengers

#### *5.6.3.1 Direct Interactions*

Passengers could impact direct interactions by determining the window a law enforcement officer might approach to speak with someone, since a passenger could be in any seat in the ADS-equipped vehicle. A separate response wanted to know if passengers would be able to operate the windows, or their window, in the vehicle for law enforcement to speak with them. This response was binned as a direct interaction as law enforcement may request a passenger to operate the window, as shown below in Table 36.

**Table 36. ADS-related Direct Interactions Associated with Passengers during Traffic Stops and Checkpoints**

| Participant Feedback | Domain (Responses) |
|---|---|
| Determine where to approach the vehicle | LE (2) |
| Determine if passengers can operate windows | LE (1) |

#### *5.6.3.2 Informational Interactions*

Responses regarding how passengers in the vehicle may change interactions were similar to those regarding ADS-equipped vehicles in general, found in Table 37. Primarily, the need is to know how to determine who is responsible for the ADS-equipped vehicle, not necessarily the ADS's conduct. However, law enforcement may investigate to find out if a passenger could potentially be responsible for any action the vehicle took prior to the stop.

If the ADS is malfunctioning, leading to a stop, and passengers are present, law enforcement would need to know the extent of that malfunction and if passengers were safe to remain in the vehicle.

As is typical in traffic stop operations, police take note of how many occupants are inside a vehicle, and this would remain true in the case of ADS-equipped vehicles. However, it may be important to know if there were no passengers in the vehicle per the following excerpt:

> That's another officer safety concern, because you knock on the window and no one is answering. Hopefully you can still see inside, but let's say it's all dark windows all around and you can't tell from the outside if the driver is refusing to open the door or roll down the window or if the vehicle has no driver whatsoever. You can look inside to realize there is no steering wheel and no gas pedal, no gear, so it's one of those automatic vehicles. It's going to be a situation where it's going to be challenging for us to realize it. We may be there on a felony stop with our guns out, trying to tell the driver to come out, just to find out that there's no driver inside.
>
> ***– Rural Town Law Enforcement***

**Table 37. ADS-related Informational Interactions Associated with Passengers during Traffic Stops and Checkpoints**

| Participant Feedback | Domain (Responses) |
|---|---|
| Determine responsibility | LE (3) |
| Assess whether passengers are at risk of malfunctioning vehicle | LE (3) |
| Identify number of occupants | LE (2) |
| Identify who to talk to | LE (1) |
| Acquire vehicle data | LE (1) |

## 5.7 Abandoned or Unattended Vehicles

This Abandoned and Unattended Vehicle scenario was presented to 33 different law enforcement officers (divided by domain in Table 38). There are 10 interview participants and 23 focus group participants represented in the results.

**Table 38. Breakdown of Participants for Abandoned and Unattended Vehicle Scenario**

| Domain and Category | Number of Participants in Scenario |
|---|---|
| State Police | 12 |
| Rural County Police | 2 |
| Populous County Police | 5 |
| Rural Town Police | 7 |
| Urban City Police | 7 |
| **Total** | **33** |

### 5.7.1 Interactions with ADS-equipped Vehicles in DO Associated with Abandoned or Unattended Vehicles

#### *5.5.1.1 Direct Interactions*

The need to know how to disable the ADS-equipped vehicle was the only direct interaction conveyed through the interviews. If a vehicle was left on and needed to be towed, law

enforcement would currently need to find a method of shutting the vehicle down. In the case of ADS-equipped vehicles, law enforcement would need to act similarly. Responses also indicated that shutting down or disabling the vehicle may be done for safety's sake to protect other motorists or themselves in the event the vehicle was malfunctioning. Another reason for disabling the vehicle stemmed from the need of law enforcement to often be on the scene for and provide assistance with towing operations. For their own safety and the safety of towing operations, they would want to ensure that the vehicle could not activate. The number of responses to this direct action is found in Table 39 below.

**Table 39. ADS-related Direct Interactions Associated with Abandoned or Unattended Vehicles**

| Participant Feedback | Domain (Responses) |
|---|---|
| Disable vehicle | LE (5) |

#### *5.5.1.2 Indirect Interactions*

Indirect interactions centered on interacting and potentially communicating with the abandoned or unattended vehicle. One concern was with how law enforcement could signal an ADS-equipped vehicle to stop if it starts to leave while they are investigating, especially since at this point they would be behind the ADS-equipped vehicle and outside of their own vehicle. Law enforcement may also need to communicate to the ADS-equipped vehicle to stop if it became activated during a towing operation as they suspected it could potentially be capable of doing.

One response indicated the need for communicating with the ADS-equipped vehicle to learn its intentions. Speculations included a verbal interaction but also indicated the use of technology to determine the reason a vehicle was stopped; for example, waiting for a passenger, due to a malfunction, or for some other reason. This response is shown below in Table 40.

While not a particular need, one response indicated that they may use other vehicles to barricade an abandoned vehicle in place so that it could not leave the scene if they needed to inspect or tow it.

**Table 40. ADS-related Indirect Interactions Associated with Abandoned or Unattended Vehicles**

| Participant Feedback | Domain (Responses) |
|---|---|
| Anticipate vehicle's reactions when approached | LE (4) |
| Signal vehicle (using another vehicle) | LE (2) |
| Communicate with vehicle | LE (1) |

#### *5.5.1.3 Informational Interactions*

Informational interactions were the most common to this scenario and primarily involved knowing whom to contact regarding the vehicle and how to contact them. The need to contact the owner is multifold. First, the owner may be able to inform law enforcement whether the ADS-equipped vehicle is parked there for a specific reason, due to malfunction, or another scenario. Second, the owner will need to be alerted that the ADS-equipped vehicle has been located by police and that it needs to be removed in a specific timeframe. In the event the vehicle is creating a hazard, police may require the owner or someone in control to move it off the roadway and to a safer location. Additionally, if the vehicle is creating a hazard or is violating the law, law enforcement may contact the owner to alert them that the vehicle is being towed.

As mentioned, via the process of contacting an owner, law enforcement would want to know the ADS-equipped vehicle's intentions for being stopped at that location. Some responses speculated that this information could be broadcast from the ADS-equipped vehicle or it could be identified as a rideshare vehicle quickly, without contacting anyone first. Status information such as whether the ADS-equipped vehicle was in a standby mode or currently operable, malfunctioning, or if the vehicle needed help are all things law enforcement would want to know. Speculations included visual indicators or some method of communicating with the ADS-equipped vehicle to extract that information.

While some responses indicated that an ADS-equipped vehicle would not impact their current protocols (i.e., towing when violating the law or creating a hazard), others indicated that they would still benefit from knowing it was driverless. For example, knowing the vehicle was driverless might mean that they would approach it more cautiously if they were uncertain of its operational status. If it were also known that no there were no occupants, a search would not be needed for anyone who may have left the vehicle on foot. The means for contacting the party responsible for the vehicle could be expedited if they could clearly see that the ADS-equipped vehicle is driverless or of a certain brand or model. In addition, law enforcement could better anticipate what to expect in terms of how the ADS-equipped vehicle will react to and behave. Again, some responses indicated concerns about the ADS-equipped vehicle driving away, for example, when stopped for an inspection.

When investigating an abandoned vehicle, it is already current protocol to try to determine a reason for the vehicle to be there, including looking for damage or a flat tire. However, most mechanical failures are not visibly obvious. For an ADS-equipped vehicle in DO, it may benefit law enforcement to know if the vehicle is stopped in that location due to a malfunction of some sort versus some other reason that would require them to investigate further. Additionally, if a malfunction could be identified, law enforcement may seek to disable the vehicle so that it cannot resume travel until repaired. These responses are captured in Table 41 below.

**Table 41. ADS-related Informational Interactions Associated with Abandoned or Unattended Vehicles**

| Participant Feedback | Domain (Responses) |
|---|---|
| Contact owner or controller of vehicle | LE (11) |
| Determine the intentions of the vehicle (abandoned, malfunctioning, or staging) | LE (9) |
| Recognize if vehicle is operating in DO | LE (8) |
| Identify potential malfunctions | LE (5) |
| Anticipate how vehicles will react/behave | LE (4) |
| Use VIN to identify owner | LE (1) |

Additional comments and responses, as with other scenarios included in the interviews, involved anticipated training. Training ideas included universal ways to stop and prevent ADS-equipped vehicles from moving, how to identify specific ADS-equipped vehicles and their capabilities, how to communicate with the ADS-equipped vehicles, and general information regarding what to do when they encounter an ADS-equipped vehicle capable of being operated in DO.

### 5.7.2 When to Know a Vehicle is Equipped with Automation in DO

The following section details the overall responses given for when it would benefit an operation most to know a vehicle was and ADS-equipped vehicle in driverless mode.

When investigating an unattended or potentially abandoned ADS-equipped vehicle, law enforcement overwhelmingly responded that they would need to be able to know an ADS-equipped vehicle was able to be operated in DO at the scene, either by visibly detecting a light, symbol, or other obvious indicator on the vehicle or by running the license plate through a database. In general, there were two main reasons provided for needing to know the ADS-equipped vehicle's capabilities. The first was to prime law enforcement for what to expect when approaching the vehicle in terms of how the ADS might react or behave. The second reason was

so that they could immediately know who to contact, whether it be an owner, a dispatch office, or a company, to save the time of actively searching for a driver in the nearby area.

### 5.7.3 Interactions with ADS-equipped Vehicles in DO Associated with Abandoned or Unattended Vehicles in Need of Immediate Removal

The following section details how interactions and operations may change if an ADS-equipped vehicle in DO were parked in an area that warranted its immediate removal.

Many law enforcement responses, found in Table 42, pertained to the towing operation and that, in most cases, a law enforcement officer will remain on scene with a towing agency while a vehicle is being towed. This action is dependent on officer discretion, priority, and department policy. Answers regarding direct interactions focused on disabling the ADS-equipped vehicle to prevent it from moving or reacting to a towing operation. In the event that an abandoned ADS-equipped vehicle's registration is outdated, it may need to be cited and towed, in which case law enforcement would again want to disable it so that it could no longer operate until reregistered. Additionally, if an ADS-equipped vehicle is positioned hazardously in the roadway, one response from law enforcement wondered if it could be manually moved from the roadway, either by pushing it or operating it somehow from inside.

**Table 42. ADS-related Direct Interactions Associated with Abandoned or Unattended Vehicles in Need of Immediate Removal**

| Participant Feedback | Domain (Responses) |
|---|---|
| Disable vehicle | LE (9) |
| Manually move vehicle out of the way | LE (1) |

Based on their limited knowledge of how the ADS will behave, a law enforcement response indicated that if an ADS-equipped vehicle warranted immediate removal from an area, they might block the vehicle in with other vehicles so that it could not leave the scene. This blocking of the vehicle could be interpreted as an indirect interaction, as law enforcement would be using other vehicles or objects that the ADS-equipped vehicle could sense to keep it in place.

Law enforcement also would like to know how to interact or communicate with the ADS-equipped vehicle in this scenario, whether verbally or by some other means, to determine if there is a driver in the area to speak to in order to learn the vehicle's intentions, or to direct the vehicle to another location. This response is captured in Table 43 below.

**Table 43. ADS-related Indirect Interactions Associated with Abandoned or Unattended Vehicles in Need of Immediate Removal**

| Participant Feedback | Domain (Responses) |
|---|---|
| Communicate or interact with vehicle | LE (2) |

Informational interactions were the most common for this scenario, and the responses, found in Table 44, centered on contacting someone who may be able to influence or take responsibility for the vehicle. Responses indicated that the ability to communicate with someone "fairly quickly" would benefit the operation most to determine the ADS-equipped vehicle's intentions or to identify malfunctions. Responses speculated that a controller via a dispatch office may have the ability to make the ADS-equipped vehicle relocate to a safer location. Law enforcement also indicated that, as part of their current operations, they would need to contact the owner to let them know the vehicle was going to be towed.

**Table 44. ADS-related Informational Interactions Associated with Abandoned or Unattended Vehicles in Need of Immediate Removal**

| Participant Feedback | Domain (Responses) |
|---|---|
| Communicate with the vehicle's controller | LE (7) |
| Contact the vehicle owner | LE (7) |

Responses that indicated the operation would have no impact on current law enforcement protocols regarding abandoned or unattended vehicles (LE 8) mentioned that if the ADS-equipped vehicle were creating a hazard or was violating a law, it would be treated no differently and simply towed from the area.

## 5.8 Stabilization and Extrication

This Stabilization and Extrication scenario was presented to nine different fire and rescue personnel, who all happened to be paid. Seven participated as part of a focus group, and two took part in one-on-one interviews.

### 5.8.1 Interactions with ADS-equipped Vehicles in DO Associated Stabilization and Extrication

#### *5.8.1.1 Direct Interactions*

Stabilization and extrication are operations that largely require direct interactions. Responses indicated that fire and rescue teams would need to know how to disable and cut the power to the ADS-equipped vehicle to prevent it from moving. These operations are already a part of the

stabilization protocol; however, responses indicated that disabling an ADS-equipped vehicle capable of DO may be critical after an incident as the ADS might be more prone to a malfunction that would need to be neutralized.

Disabling the vehicle and cutting the vehicle's power are two separate actions. Disabling the vehicle is to ensure it physically cannot move. This is accomplished by barricading, using chocks, or placing in the vehicle park. Cutting the vehicle's power removes the possibility of the vehicle's ignition starting and having a burning fuel source or active electrical charges. Both actions are required for all stabilization procedures to ensure safety for first responders and patients.

Two responses indicated that during a stabilization procedure, if unfamiliar with an ADS-equipped vehicle or unable to access the interior of the vehicle, a public safety official would ask an occupant to start or shut down the vehicle (if they knew how to operate the vehicle or if the controls were easier for them to reach). Additionally, the need to know how to access the interior of the ADS-equipped vehicle was expressed, assuming the design of the vehicles would be vastly different than current models. These responses are captured in Table 45 below.

**Table 45. ADS-related Direct Interactions Associated with Stabilization and Extrication**

| Participant Feedback | Domain (Responses) |
|---|---|
| Disable vehicle (park and paralyze) | FR (5) |
| Cut power to the vehicle | FR (4) |
| Start the vehicle if components need operated | FR (1) |
| Access vehicle interior | FR (1) |

#### *5.6.1.2 Indirect Interactions*

No indirect interactions were included in the responses for this scenario.

#### *5.6.1.3 Informational Interactions*

Informational interaction responses, found in Table 46 below, included the need to know of any changes to the equipment required for stabilization due to the introduction of ADS-equipped vehicles. Responses indicated that prior knowledge of whether the ADS-equipped vehicle or vehicles contained passengers would impact the equipment needed on scene and how fire and rescue teams might respond. Additionally, fire and rescue would need to be aware of any unique hazards associated with the ADS-equipped vehicle in terms of where electrical wiring and airbags were placed in the vehicle.

Appropriate equipment and the knowledge of unique hazards can be associated with the "need for training" that was also expressed in the response.

**Table 46. ADS-related Informational Interactions for Stabilization and Extrication**

| Participant Feedback | Domain (Responses) |
|---|---|
| Determine if vehicle contained occupants prior to arrival | FR (2) |
| Determine appropriate equipment for stabilization | FR (1) |
| Identify potential unique hazards associated with vehicle | FR (1) |

### 5.8.2 When to Know a Vehicle is Equipped with Automation in DO

Similar to other scenarios, responses indicated that knowing an ADS-equipped vehicle was being operated in DO would be important as soon as possible and potentially prior to arrival as that would assist in allocating resources, especially if the vehicle had no passengers at all. Additionally, any specialized equipment or personnel required for interacting with the ADS-equipped vehicles would need to be dispatched to the scene. One participant speculated that prior knowledge would also allow an ADS-equipped vehicle's remote fallback-ready driver to power down the vehicle or manipulate it prior to emergency service's arrival.

### 5.8.3 Interactions with ADS-equipped Vehicles in DO Associated with Stabilization and Extrication involving Passengers

This question was asked even though that stabilization and extrication procedures are not required if a vehicle has no passengers. However, anecdotally, one response indicated that the presence of passengers may require more caution when de-energizing and controlling an ADS-equipped vehicle. The primary need to know about passengers, according to two responses, centered on the search for potentially ejected occupants. They would need to know if the area warranted a search for anyone who may need treatment.

> Well, of course, make sure that everyone is okay, if there are patients, and you also gotta know, if it is a driverless vehicle, so you're not showing up and looking for the driver. Did they get ejected? Are they in the woods somewhere? You would need to know if there are any passengers or not 'cause you need to know if: one, you're looking for someone, or two, if you need to treat someone.
>
> ***– Career Fire and Rescue***

## 5.9 Additional Participant Feedback

The final questions of the focus groups and one-on-one interviews explored participants' perspectives on the scenarios affording the greatest opportunities for improved interactions, final thoughts regarding the scenarios, and organizational and personal experience planning for or interacting with autonomous vehicles.

### 5.9.1 Scenarios Affording the Greatest Opportunities for Improved Interactions

When asked which of the scenarios they thought would afford the greatest opportunities for improved interactions as a result of the introduction of ADS-equipped vehicles in DO, participants discussed opportunities associated with traffic direction and control (17 responses) and responding to an incident (15 responses), followed by traffic stop and securing a scene (both 10 responses; Figure 60).

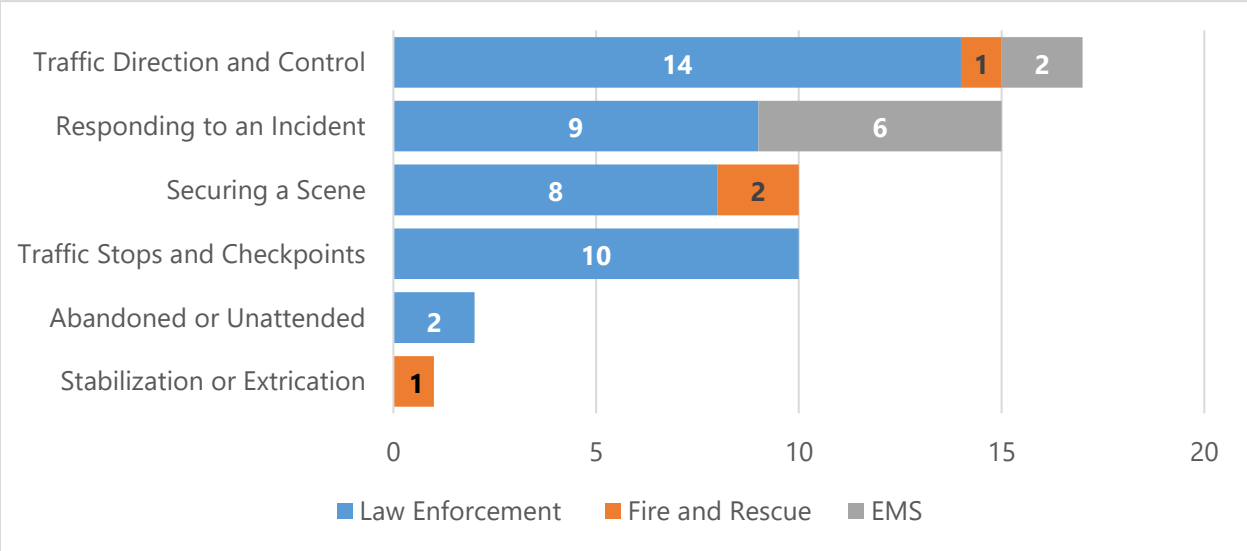



**Figure 60. Perceptions of the scenario affording the greatest opportunities for improved vehicle interactions resulting from ADS-equipped vehicles in DO.**

Responses indicating an improvement in predictable travel patterns and a reduction in human driver uncertainty were the primary reasons noted for traffic direction and control (8 LE, 5 EMS) and responding to a scene (9 LE).

> [From] a technology standpoint, one would think it would be able to recognize an emergency vehicle sooner than a human-—in many situations—and then would more aptly respond in a certain way, which, we could know what that way should be "slow and pull to the right," for example, as being one of them. I think that that would probably be the best, the biggest opportunity for improvement in the way the motoring public interacts with emergency vehicles.
>
> ***– Career EMS***

> It would be very beneficial to not have all the unknowns like you do with members of the public. Just having a vehicle—okay, I know it's going to be doing this, it's going to slow down. It's going to pull to the right, or "A" or "B," it's going to pull to the left, or it's going to be doing a specific thing. Rather than "Joe Blow" out in the public. Either he slams on his brakes, or he goes the wrong direction, or he pulls right back into your travel lane. It'd be nice to know something is going to be fixed in stone, what that vehicle's supposed to do.
>
> ***– Canadian Law Enforcement***

> If it recognizes [lights and sirens or strobes] and it pulls over to the right, we're gonna have a lot less issues of them taking away the human element of people doing some crazy things, as opposed to the other situations where, I think we've just come up with a bunch of potential issues that could arise.
>
> ***– Urban Law Enforcement***

Nine responses focused on benefits associated with information to be obtained from the ADS-equipped vehicles in DO (7 LE, 1 FR, 1 EMS). Several noted that they anticipated being able to receive data regarding the state of or location of the vehicle and presence or absence of passengers (4 respond to an incident, 2 securing a scene), which in turn would allow responders to improve their response and allocation of resources.

> [It] would be the responding to the scene 'cause the more information that we can feed into [the emergency coordination center (ECC)], so when we respond—the more heads up alert we can get from ECC the better. And if they can somehow let ECC know that this is a driverless vehicle—so when we respond to the scene, we've got more information, and we're not getting on the scene and going, 'Oh my God, it's a driverless vehicle.'
>
> ***– Career EMS***

> [If] they were actually just able to pinpoint location and tell us exactly where they are, it would probably speed up our response time. I think that would be the number one benefit. And then the ability to gather any kind of information through any kind of technology, so they would help us respond to a scene with the right information and the right tools to help a situation would be, to me, the most beneficial I think.
>
> ***– Urban City Law Enforcement***

Three noted the benefits of receiving unbiased incident-related information when securing a scene.

> Most vehicles are going to capture real time, real data, and that's going to be consistent. It's never going to deviate based on emotion or anything else.
>
> ***– State Law Enforcement***

Ten responses (2 securing a scene, 2 traffic direction and control, 6 traffic stop) indicated a reduction in exposure due to reduced interactions with individuals.

> Well, in the perfect world, if everything was completely automated then you wouldn't need anybody out there standing there directing traffic you could control from a traffic control center.
>
> ***– State Law Enforcement***

> Less people to deal with [when securing a scene]. Especially if they're by themselves. Or the car's the only issue and somebody ran into the car.
>
> ***– Urban City Law Enforcement***

> If they've broken a law, I mean, why do I even need to pull the car over? I could just take the tag and go talk to COMPANY. Fine them. So maybe [traffic stop] I would say would be safer because maybe I wouldn't even have to pull over car.
>
> ***– Royal Canadian Mounted Police***

Two responses associated with traffic direction and control noted advantages of being able to potential reroute ADS-equipped vehicles.

> [If] your system or your software, especially those detour routes we were talking about earlier and getting people away from congestion, if they knew in advance, three miles up, there's something or they can take the next exit and bypass it automatically without even interacting with the police or emergency services, you're going to alleviate some of the pressure and/or secondary crashes that might occur.
>
> ***– State Law Enforcement***

### 5.9.2 Additional Aspects of Operations Associated with Presented Scenarios

Participants were asked if there were any other aspects of their operations associated with the scenarios that the researchers should be aware of or that should have been discussed. Thirty-two participants offered no additional feedback. Thirteen reflected questions or comments associated with general operations and/or capabilities associated with ADS-equipped vehicles in DO (e.g., how will the vehicle react in certain situations or procedures for interacting with ADS-equipped vehicles; 7 LE, 6 EMS). One law enforcement officer suggested a need for a standardized protocol for ADS-equipped vehicles to follow in terms of contacting the 911 center.

> [B]ut there probably needs to be a standardized emergency protocol for—that's for any brand of automated vehicle, that it contacts somehow the 911—automatically contacts the 911 center or whatever when it's involved in an incident—I would think, and send certain information if it can, if it's still capable of doing that. And in the way for an officer or someone to know whether the vehicle's occupied or not. But again, if it's so destroyed then it might not be able to tell you that, you may have to go back to the computer records which—and maybe that kind of information should be deemed to be public so that you can't—you don't have to go through the hassle of getting a search warrant just to figure out if the vehicle is occupied or not. [Because] that's a lot of wasted time where somebody's injured, that they might not be getting the help they need.
>
> ***– State Law Enforcement***

Five indicated a desire for training to prepare them to interact with ADS-equipped vehicles (2 LE, 3 EMS). One law enforcement officer offered an example of a current statewide traffic control training that was required of all those on the highway who would potentially interact with vehicles (e.g., state law enforcement, fire and rescue, Department of Transportation employees, tow-truck operators). Two law enforcement officers catastrophized about the potential to engage these vehicles for illegal activities (e.g., bomb transport, human trafficking). Three noted a need to differentiate between passenger and commercial vehicles (LE), and one each noted the need to have policies for handling first-responder-involved incidents (e.g., a fire truck is involved in a crash on the way to a scene; FR) and electric-vehicle-related medical care (EMS).

Several participants offered constructive feedback that may enhance understanding of potential interactions within each scenario. These suggestions include looking further at nighttime driving and associated challenges such as reduced visibility (1 EMS) and understanding complex situations (1 EMS) like intersections and buffer zones around blocking emergency vehicles.

> Recently we had to close a 3, 2-3 lane pretty major highway down due to a mudslide for 13 hours and I can think, how many times in that 13 hours till I finally lock myself in the truck that I have to walk up to someone and explain something to them through their window. And you're not going to be able to do that to an automated vehicle. So we'll be able to figure out what to do. I mean, literally probably 10% of the people that came through that intersection had to question that they couldn't figure out by looking at what I was doing with numerous error boards and all kinds of other stuff I was trying to use. So, can the automated vehicle do all that? And you know, when, it's easy to say no it can't.
>
> ***– Career EMS***

> If you have a fire truck parked sideways in the road, we talked about blocking. So we generally park at an angle, and then it goes around that fire truck. Does it know enough to not immediately come back into the lane, because on the other side of that fire truck is some buffer space, and then there's a car accident, and then there's people working, then there's an ambulance. How does it know all those things that, can figure all that out like most humans do?
>
> ***– Career EMS***

### 5.9.3 Additional Scenarios to Consider

When asked about additional scenarios that should be considered, 36 offered no further suggestions. Those offering suggestions focused on everything from water entry (1 FR) and evacuation scenarios (1 FR) to malfunctioning vehicles (1 FR, 1 EMS) to cyberattack scenarios (1 LE, 1 EMS) to scenarios involving illegal activities (4 LE; Figure 61).

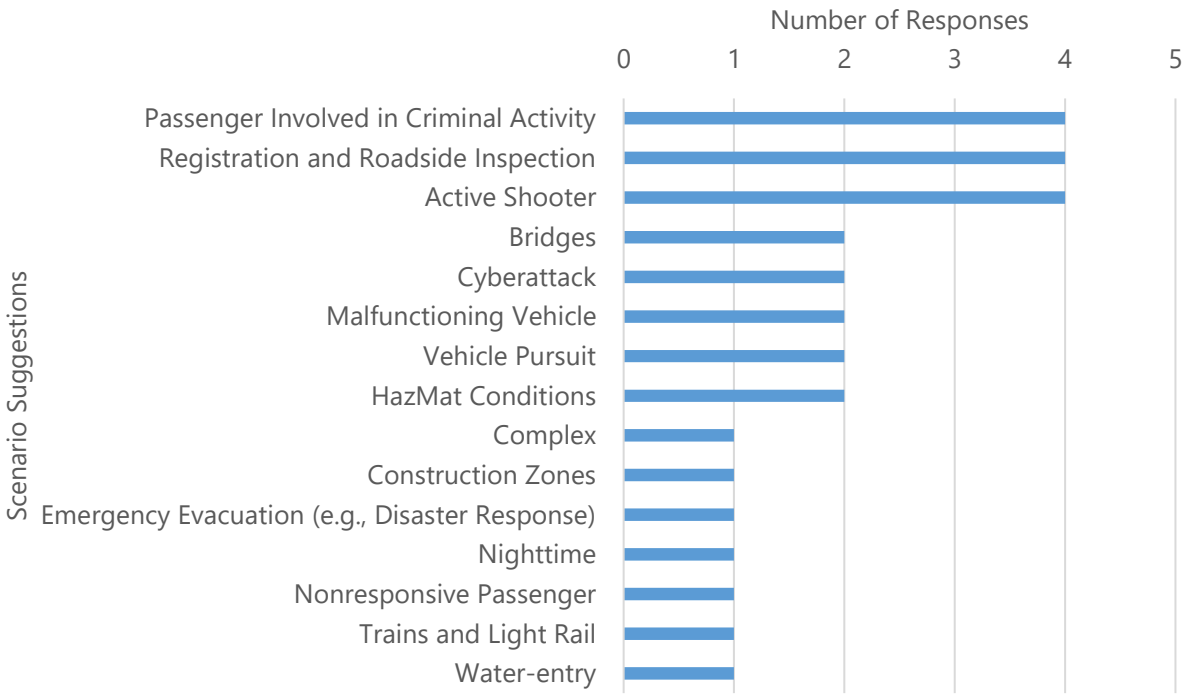



**Figure 61. Additional scenario suggestions.**

### 5.9.4 Experience with Automated Vehicles

The final two questions obtained insight into participants' experience with automated vehicle systems. First, they were asked if their jurisdiction or department had any experience planning for or interacting with automated vehicles. Forty-nine participants indicated no organizational experience, compared to 25 who indicated experience (Figure 62). Planning and experience ranged from conference attendance (1 LE), general planning and awareness discussions (10 LE, 2 EMS) to planning committees (4 LE, 2 EMS), discussions with technologies companies (2 LE) to a state-wide license plate registration system (CT; 1 LE) to local ordinances (1) and participation in research or pilot testing (4 LE).

On a personal level (Figure 63), only six law enforcement officers indicated having experience interacting with automated vehicles versus the remaining 65 participants, who noted no personal experience. Of those with experience:

- One experienced a demo of a driverless bus at a conference;
- One attended a demo at a company's test site;

- One participated in a study of commercial motor vehicle platooning that took place on the state's turnpike; and,
- Three had exposure through conference attendance.

Of those without experience, thinking beyond passenger vehicles, one law enforcement officer indicated familiarity with semi-autonomous farm machinery.

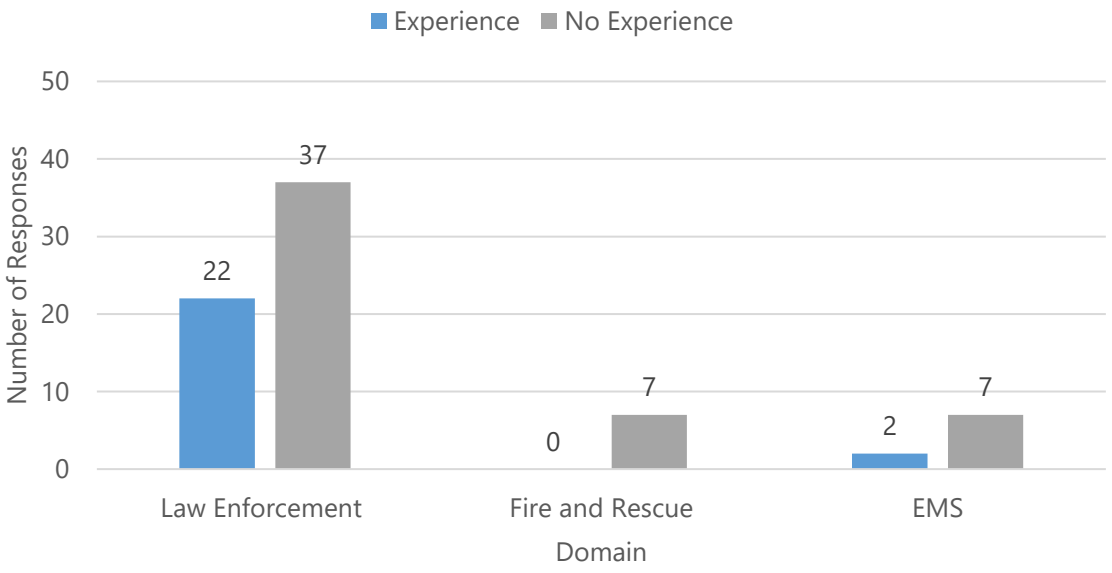



**Figure 62. Organizational experience planning for or interacting with automated vehicles.**

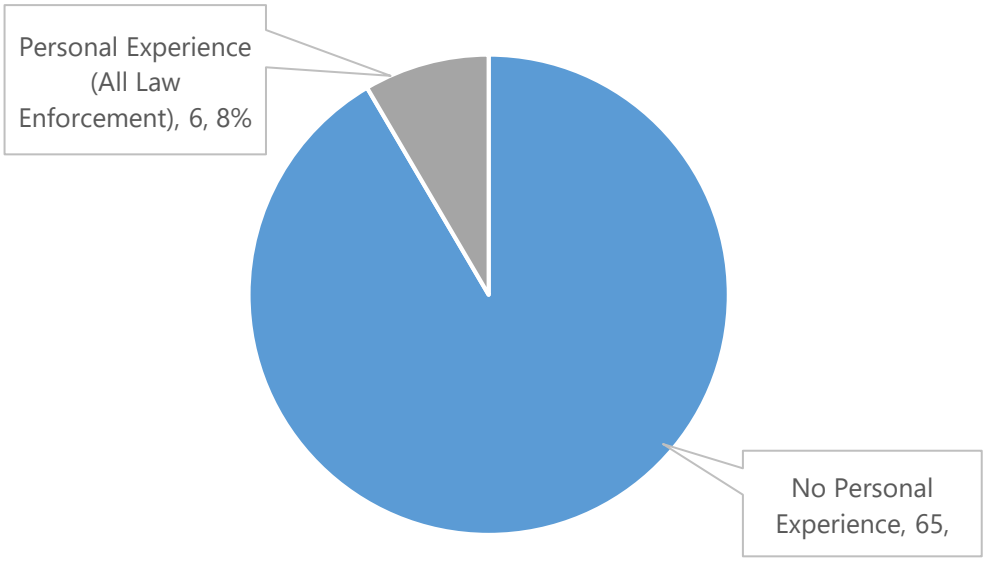



**Figure 63. Participants' personal experience with ADS-equipped vehicles.**

# Chapter 6: Summary of DO Participant Feedback Assessment Key Findings

As pertaining to ADS-equipped vehicles in DO, it was determined that very few direct interactions or needs regarding direct interactions were highlighted. Of those mentioned in responses, the most commonly recurring and popular response referenced the need to know how to disable the ADS-equipped vehicle. This issue factored into securing a scene (49 responses), addressing an abandoned vehicle (5 responses), and conducting stabilization and extrication (5 responses).

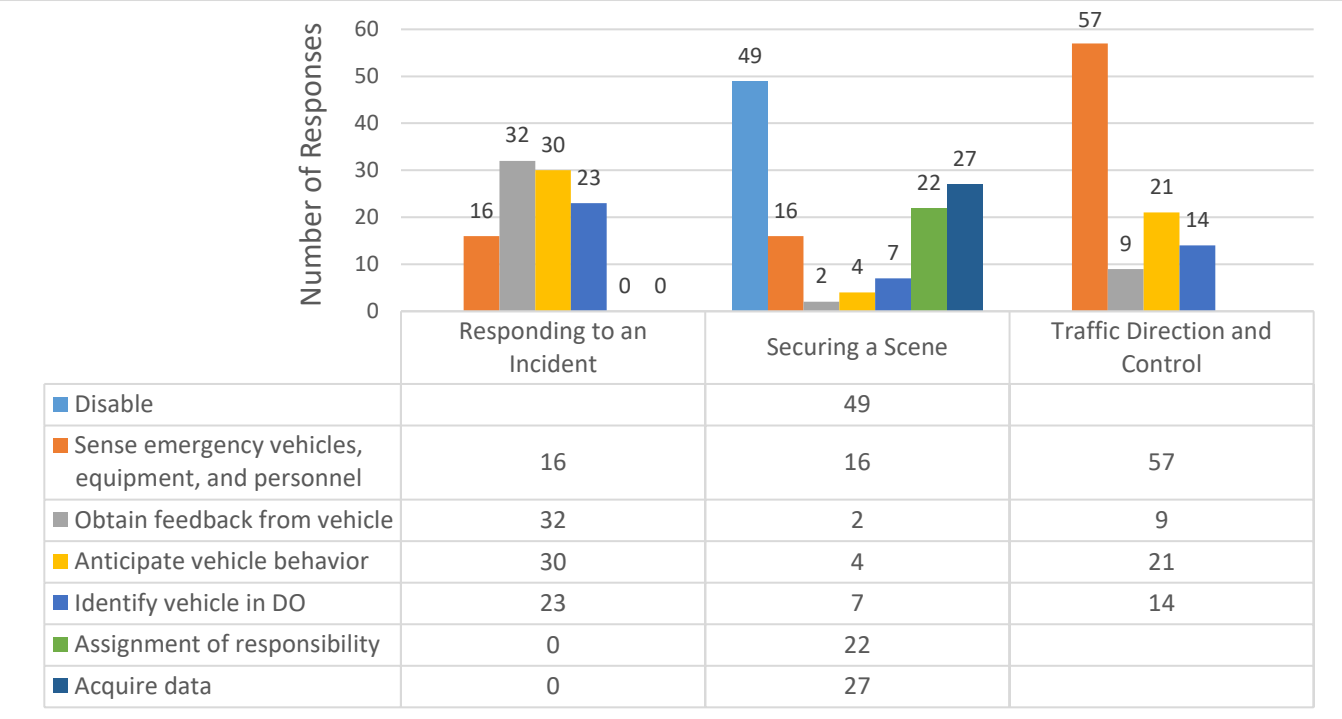
The scenarios of responding to an incident and conducting traffic direction and control received no specific changes to existing direct interactions due to the introduction of ADS-equipped vehicles in DO.

Responses involving indirect interactions were much more common than direct interactions. There were two key indirect interaction themes that spanned multiple scenarios. First, how to signal to an ADS-equipped vehicle in DO when and how to maneuver when securing a scene (16 responses) or conducting traffic control (57 responses). This includes signaling using temporary traffic control devices, manual traffic control by a public safety official, or by vehicle placement and lighting. The second theme was how an emergency vehicle may be able to communicate with an ADS-equipped vehicle in DO to either move out of the way when responding to an incident (16 responses) or to pull over and stop when conducting a traffic stop (19 responses).

Informational interactions were much more varied as public safety officials that were interviewed suggested as much information as possible prior to making decisions regarding the ADS-equipped vehicles in DO. One of the most common concerns was the need to know if a vehicle was an ADS-equipped vehicle in DO; this issue made up 63 total responses across all six scenarios. These responses included the need to know if an ADS-equipped vehicle is in DO as well as how they might be able to identify such a vehicle. Once the vehicle was identified, 51 responses indicated the need to know in advance how the ADS-equipped vehicle may behave in that scenario. Potential scenarios where this information would be beneficial included when a

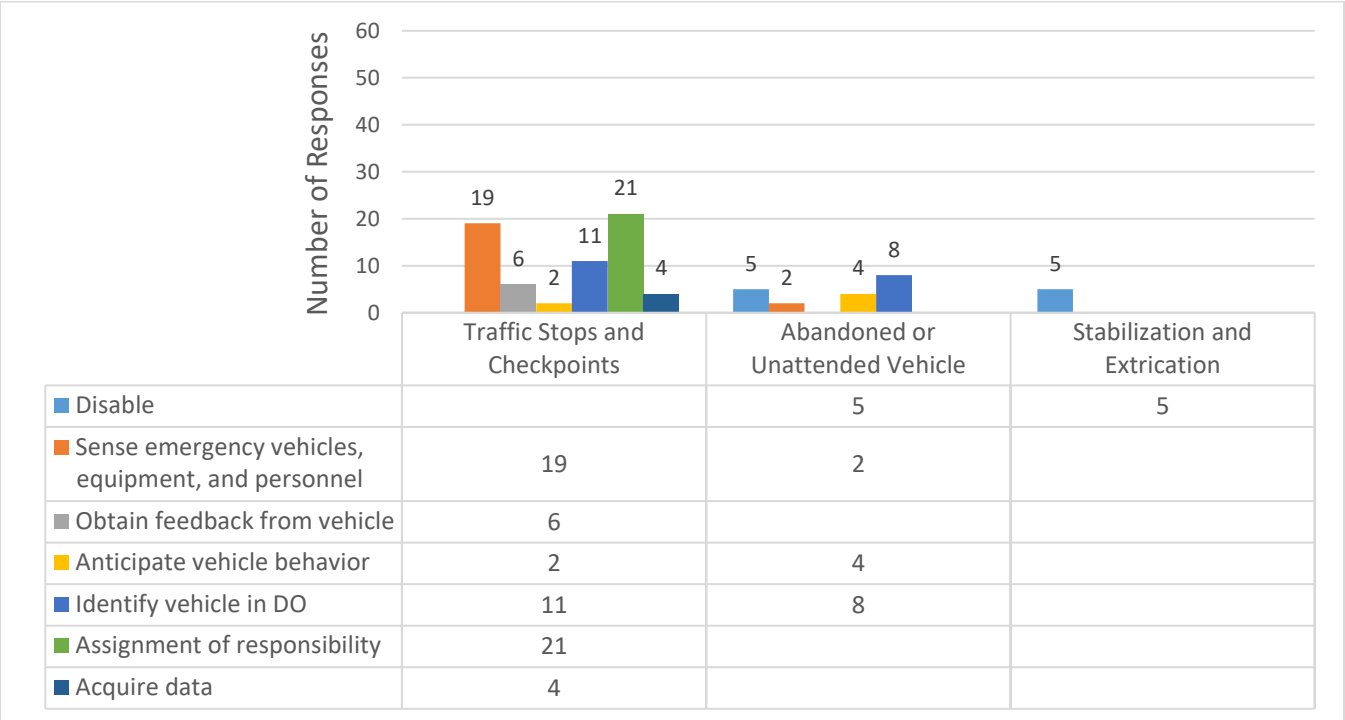
public safety official was approaching an ADS-equipped vehicle on foot, was attempting to tow the vehicle, or was attempting to signal or stop the vehicle.

The third most common informational interaction stemmed from law enforcement's need to assign responsibility or fault at an incident or during a traffic stop to be consistent with current procedures. Through 43 responses, law enforcement participants stated that assigning responsibility or issuing a citation was an important aspect of their operation. Additionally, the ability to download data from the ADS-equipped vehicle could assist in the investigation of an incident and replaces the interaction law enforcement would have with the driver, another occupant, or potential witness. For securing a scene or conducting a traffic stop, 31 total responses indicated that the need to extract data of the ADS-equipped vehicle's actions prior to an incident or stop was desired. Figure 64 and Figure 65 show the key themes across each scenario by the number of responses that included those themes or ideas.




| | Responding to an Incident | Securing a Scene | Traffic Direction and Control |
|---|---|---|---|
| Disable | | 49 | |
| Sense emergency vehicles, equipment, and personnel | 16 | 16 | 57 |
| Obtain feedback from vehicle | 32 | 2 | 9 |
| Anticipate vehicle behavior | 30 | 4 | 21 |
| Identify vehicle in DO | 23 | 7 | 14 |
| Assignment of responsibility | 0 | 22 | |
| Acquire data | 0 | 27 | |

**Figure 64. Common Themes by scenario, Part I.**




| | Traffic Stops and Checkpoints | Abandoned or Unattended Vehicle | Stabilization and Extrication |
|---|---|---|---|
| Disable | | 5 | 5 |
| Sense emergency vehicles, equipment, and personnel | 19 | 2 | |
| Obtain feedback from vehicle | 6 | | |
| Anticipate vehicle behavior | 2 | 4 | |
| Identify vehicle in DO | 11 | 8 | |
| Assignment of responsibility | 21 | | |
| Acquire data | 4 | | |

**Figure 65. Common themes by scenario, Part II.**

# Chapter 7: Potential Opportunities for Improved Interactions

The goals of this project were to determine common public safety scenarios and the step-by-step tasks associated with each, gain a more complete understanding of the interactions and needs within each scenario through subject matter review, explore how the introduction of ADS-equipped vehicles in DO may change current procedures, and determine opportunities where the interactions of public safety officials could be improved with the introduction of ADS-equipped vehicles in DO.

Through scripted interviews with 79 public safety officials from law enforcement, fire and rescue, and EMS, it was determined that, for the selected scenarios, there were several areas where the introduction of ADS-equipped vehicles in DO could potentially change how interactions occur.

While many participants indicated an inability to speculate due to their unfamiliarity with how the vehicles may be designed to operate, specific ways that their interactions could be improved in the wake of ADS-equipped vehicles in DO were mentioned. Specific improvements included a reduction in the need for traffic stops, safer traffic control to overcome driver inattention, and more information when responding to a scene. While these notions are few and broad, they encompass major aspects of the operations, many of which result in dangerous situations for public safety officials. For example, law enforcement personnel are physically vulnerable during traffic stops due to the need to stop on a roadway, leave their vehicle, and approach a waiting driver from the rear. A reduction in the need for traffic stops could diminish risks involved with the operation.

The feedback outlined by the participants regarding how specific tasks might be changed by ADS-equipped vehicles serve as a blueprint for improved interactions. The research team cannot speculate on the types of technology that will be part of an ADS-equipped vehicle in DO; however, gleaning from the responses given, the following offer some potential improvements to current interactions that were conveyed via the interviews. Summarized feedback is provided in the sub-bulleted list below.

- Consistent behavior of levels 4 and 5 ADS in how they behave and react will increase the safety of public safety officials responding to an incident, securing a scene, or conducting traffic control.
    - The ability to predict the actions of levels 4 and 5 ADS vehicle will allow emergency vehicle operators to maneuver more efficiently and with safer outcomes.
    - The ability of levels 4 and 5 ADS to behave and react accordingly to traffic direction and control may eliminate the need for extra resources or personnel at a scene or event.
- Advance information provided to dispatch centers regarding the types of vehicles, the precise location, and the number of occupants likely involved in an incident could improve the efficiency of a response as resources and personnel can be more accurately managed prior to and at a scene. The safety of responders could also be impacted as a vehicle with no occupants and no injuries, for example, may not require the response of an EMS unit.
- Advance connected-communications (e.g. vehicle-to-vehicle or vehicle-to-infrastructure communications) between public safety officials and surrounding vehicles regarding an incident, a detour, a road closure, or the approach of an emergency vehicle could benefit the safety of public safety officials during response operations and when conducting traffic control. This may also factor into a remote ability to control a vehicle, either with some technology possessed by public safety officials or via a driverless operation dispatcher.
    - Advance caution regarding traffic patterns could result in ADS-equipped vehicles detouring themselves away from a scene prior to public safety officials' arrival to conduct traffic direction or control.
    - Additionally, ADS-equipped vehicles that received advance notice and detoured appropriately would declutter the scene for emergency vehicles to arrive and lessen the queue of vehicles around a scene.
    - Advance notices to vehicles that an emergency vehicle is approaching could allow for appropriate maneuvers to be taken by the ADS-equipped vehicle ahead of

time, thus not requiring the driver of an emergency vehicle to predict the actions that a human driver might take.

  - The ability to directly communicate a precise action, such as to move toward or avoid a specific area, would be a benefit in specific situations that may require it. An example would be if a vehicle pulled to the right to yield to an emergency vehicle but inadvertently blocked an entrance the emergency vehicle needed to access.

- ADS-equipped vehicle data that could include records of speed, mechanical and digital diagnostics, and number of occupants could aid investigations at incident scenes and traffic stops immensely. The exchange of documentation, such as registration, proof of insurance, and citations may also be part of a data transfer.
  - Diagnostics, or an indication of any malfunction prior to an incident or traffic stop, or after an incident, would assist law enforcement in their investigations.
  - A report of the number of occupants who may have been inside the vehicle would assist all three domains who arrive as first responders in knowing how many passengers and potential patients are located at a scene.
  - At the very least, an indication of whether an ADS-equipped vehicle in DO was empty or occupied by at least one individual would improve the search and rescue operation, as responses indicated.

The responses provided by public safety officials on how ADS-equipped vehicles in DO will factor into their operations provide a wealth of research questions moving forward. Further research into assessing the feedback communicated by public safety officials can seek to investigate the feasibility for technology in ADS-equipped vehicles to help improve public safety interactions with vehicles of the public.

# Appendix A: Focus Group Recruitment Materials

## A.1 Focus Group Recruitment Call Script

**Note:** Initial contact between participants and researchers may take place over the phone or via email. If taking place via phone, read the following Introductory Statement followed by the questionnaire.

**Introductory Statement:**
After prospective participant calls or you call them, use the following script as a guideline

*Hello. My name is _____ and I'm with [the Virginia Tech Transportation Institute, in Blacksburg, VA, **<or the University of Massachusetts-Amherst's Traffic Safety Research Program in Amherst, Massachusetts>.** We are currently working on a research study sponsored by a consortium of automakers to assess the protocols of public safety organizations, for example, police officers, fire fighters, first responders, etc. Specifically, their interactions with non-emergency vehicles on public roadways. We are also looking at how these interactions may vary across jurisdictions and over time.*

*This study includes an in-depth review of protocols associated with several operational scenarios, such as, responding to an incident, securing a scene, and traffic direction and control. To that end, we are seeking the input of experts from a number of public safety organizations such as yours. We realize your time is valuable. However, your involvement is important to the success of this research study and may help to shape future transportation related decisions.*

*I would like to invite you to participate in an online focus group discussion. The purpose of this discussion will be (1) to better understand your responsibilities and how you potentially interact with non-emergency vehicles, and (2) to explore whether changes to the environment, circumstances, personnel, or technology impact those interactions. During the focus group study session, we will ask for your thoughts and opinions on some materials and operational procedures. All information shared during the focus group will be kept confidential. The focus group will consist of up to 5 other individuals who share similar roles and experiences as you. Your participation would be voluntary; no monetary compensation is provided.*
*Total participation time will be one session lasting approximately **125 minutes or 2 hours, 5 minutes.** Please note that all focus group sessions will be audio recorded.*

*Any questions yet? Are you interested in participating?*

*[If not interested] Do you know of any colleagues in [jurisdiction, state] who may be interested in participating?*

- *[if yes] Great! You can forward them my contact information or if you feel comfortable providing me their contact information, that works too.*
- *[if no]* Thank them for their time.

*If you are interested in participating, I need to go over some screening questions. Your responses will be used to determine eligibility and aggregated responses will be included in the final report to summarize our recruitment efforts. Any information given to us will be kept secure and confidential.*

*Do I have your consent to ask the screening questions? [If yes, continue with the questions. If no, then thank him/her for their time and end the phone call.]*

**Screening Questions**

- How many years of experience do you have as a public safety officer or first responder? _____ What is the title and number of years for each position held (all positions)?

  _____
  _____
  _____

  What is your current position? _____
  *Criterion: Must have served or currently serving as a public safety officer or first responder.*

- In terms of number of individuals, what is the size of your police force/fire department/EMS unit?

  _____
  *Criterion: Any size is eligible*

- [For fire and rescue and EMS] Is your department paid, volunteer, or a combination of paid and volunteer?

  _____
  If both, what percentage is paid? _____ Volunteer? _____
  *Criterion: Doesn't affect eligibility.*

- Do you have access to a computer, tablet, or smartphone with internet service?

  Yes _____ No _____

  *If yes*, does your computer/device have a microphone and speakers in order for you to join the study session using an online conferencing link we will send to you?

  Yes _____ No _____

  *If no, would you be willing to connect to the session using your telephone?*

  Yes _____ No _____

  *If yes*, do you have an email address where we can send you an Informed Consent Form to review, and a link to connect to the online study session?

  Yes _____ No _____

  *If yes*, are you willing to follow the link and on-line invitation to join a scheduled focus group discussion? This will require you to use your computer or tablet and/or a telephone for the entire length of the session, about **2 hours 5 minutes**?

  Yes _____ No _____

  *If connecting via tablet or smartphone, you may need to install an app to connect. Would you be willing to install the [Zoom app/GoToMeeting app] if necessary*?

  Yes _____ No _____

  Note: a camera is not needed and if they have a camera on their computer/device they will be asked NOT to use it.
  *Criterion: Must have access to email. Must be willing to connect to the video portion of the session via Internet-enabled computer, tablet, or smartphone for entire length of session. Must be willing to connect to*

*audio portion of session via computer or tablet microphone and speaker or a telephone for the entire length of the scheduled study session. If connecting to video via a smartphone or tablet, must be willing to install a mobile app if necessary. Note: If connecting via computer, an option to join from a web browser is provided so installation of an app is not required.*

If yes to all the above, "You are eligible for the study; may I please have your email address":
_____

**If Willing to Participate Schedule Focus Group Time.**

We have scheduled online focus group sessions for:

- **[Include multiple date/time options here]**

Would one of these sessions fit your schedule?

If none of these times work for you, are there other times that you know you are available?
**Determine if another session is available that fits their schedule.**
*[If none] Do you know of any colleagues in [jurisdiction, state] who may be interested in participating?*

- *[if yes] Great! You can forward them my contact information or if you feel comfortable providing me their contact information, that works too.*
- *[if no]* Thank them for their time.

**If a time has been scheduled:**

*Thank you. We have you scheduled for [Date, Time]. I will be sending you an invitation with instructions for joining the on-line study session. In addition, I will be sending you the informed consent form that reviews the information that we discussed and provides additional details and a discussion guide that we will refer to during out discussion. Please take time to review this information prior to the scheduled interview. If you do not receive our email or have any questions, please call us at XXX-XXX-XXXX. Again that number is XXX-XXX-XXXX and please refer to the "Blue" Study in your message.*
*[If more participants required] I have one last question to ask before we end the call. Are you aware of any [colleague type (fire fighter, EMT, law enforcement)] who may also be interested in participating from [jurisdiction, state]?*

- *[if yes] Great! You can forward them my contact information or if you feel comfortable providing me their contact information, that works too.*
- *[if no]* Thank them for their time.

## A.2 Focus Group Recruitment E-mail

**Note:** Initial contact between participants and researchers may take place over the phone or via email. If taking place via email, use the following introductory letter.

Subject: Invitation to participate in joint VTTI and UMASS Public Safety Study

Dear **[NAME]:**

The Virginia Tech Transportation Institute in cooperation with the University of Massachusetts-Amherst's Traffic Safety Research Program are currently working on a research study sponsored by a consortium of vehicle manufacturers to assess the protocols of public safety organizations, for example, police officers, fire fighters, first responders, etc. Specifically their interactions with non-emergency vehicles on public roadways. We are also looking at how these interactions may vary across jurisdictions and over time.

This study includes an in-depth review of protocols associated with several operational scenarios, such as, responding to an incident, securing a scene, and traffic direction and control. To that end, we are seeking the input of experts from a number of public safety organizations such as yours. We realize your time is valuable. However, your involvement is important to the success of this research study and may help to shape future transportation policy-related decisions.

I would like to invite you, or one of your similarly qualified colleagues, to participate in an online focus group discussion. The purpose of this discussion will be (1) to better understand your responsibilities and how you potentially interact with non-emergency vehicles and (2) to explore whether changes to the environment, circumstances, personnel, or technology impact those interactions.

During the focus group, we will ask for your thoughts and opinions on some materials and operational procedures. The discussion will be one session lasting approximately 125 minutes (2 hours, 5 minutes) during daytime or early evening hours. Please note that all focus group study sessions will be audio recorded. All information shared during the focus group will be kept confidential. Your participation would be voluntary; no monetary compensation is provided. However, your opinions and perceptions may influence the development of future transportation-related policy initiatives. Further, there may be up to 5 other participants with you in the focus group who share similar roles and experiences within your domain.

I would be happy to provide you with additional details about this request for assistance. Please feel free to contact me at [number] or [email].

Sincerely,
**Name, Title**

## A.3 Focus Group Confirmation E-mail

Subject: Confirmation for VTTI/UMASS Public Safety Study

Dear [Name]:

Thank you for agreeing to participate in an online focus group that is being conducted by the Virginia Tech Transportation Institute in cooperation with the University of Massachusetts-Amherst's Traffic Safety Research Program on behalf of a consortium of automakers. As part of this research study we are assessing the protocols of public safety organizations. Specifically, this study will examine how law enforcement officers, fire fighters, and other first responders interact with non-emergency vehicles on public roadways. We are also looking at how these interactions may vary across jurisdictions and over time.

The purpose of this focus group will be (1) to better understand your responsibilities and how you potentially interact with non-emergency vehicles and (2) to explore whether changes to the environment, circumstances, personnel, or technology impact those interactions. During the focus group, we will ask for your thoughts and opinions on some materials and operational procedures.

**Focus Group Process**

Your focus group is scheduled for **[DATE, TIME] a**nd will run for approximately 125 minutes (2 hours 5 minutes). Please log into the focus group using the following information **[Include Zoom/GoToMeeting Information Here]**. Additional **[Zoom or GoToMeeting]** information is included below for your reference.

During the course of the interview you will:

- Be asked to log into the online interview session and connect to the audio portion of the interview via the hosting site's (i.e., Zoom's or GoToMeeting's) voice over internet protocol (VOIP) or a telephone.
- Be reminded of the information included within the attached Informed Consent Form. Please review this information prior to our session. You will be provided an opportunity to discuss any questions or concerns you have with a researcher.
- Provide verbal consent to participate in the study and to be audio recorded.
- Listen to a brief description of the research study after which you will be asked to provide your opinions and feedback on a number of operational scenarios that may include, but are not limited to responding to an incident, securing the scene, or traffic direction and control.

In order to facilitate the free flow of conversation, prior to beginning our discussion, we will ask for your permission to audio record our conversation. The audio recordings will be used to supplement our handwritten notes. Should you decline to grant your permission to be recorded, we will ask you to log off of the call.

To further facilitate the discussion, we have attached a list of questions that will be guiding our discussion. We encourage you to use this list to take notes during our discussion.

**Confidentiality**

- Individual responses will be aggregated for reporting purposes, and general information (e.g., police officer, fire chief, etc.), not individuals, will be referenced in the research reports. Should you agree to have our discussion audio recorded, your name will not be associated with your transcript.

- The audio recordings will be deleted upon completion of the transcription process; however, the researchers and the study sponsors will retain copies of the transcripts. Again, all personally identifying information will be redacted from the transcripts.
- It is possible that the Virginia Tech Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human participants involved in research.

You are free to withdraw from this study at any time or decline to answer any questions that you choose. Should you have any questions about this study, you may contact:

| | | |
|---|---|---|
| Travis Terry | 540 231-3955 | tterry@vtti.vt.edu |
| Tammy Trimble, Ph.D. | 540-231-1036 | ttrimble@vtti.vt.edu |
| Robin Riessman | 413-577-1035 | riessman@ecs.umass.edu |

Should you have any questions or concerns about the study's conduct or your rights as a research subject or need to report a research-related event, you may contact the Virginia Tech IRB at 540-231-3732 or irb@vt.edu.

We appreciate your willingness to share your experience with us and look forward to talking with you further about this exciting research study.

Sincerely,

**Name, Title**
**Email | Phone**

Attachments: Informed Consent Form. Focus Group Discussion Questions

**Zoom User Information**

- View a short video explaining how to join a Zoom meeting: **Attend a meeting**
  - **Note:** We will not be using the video option available through Zoom. You **do not need** a web camera to participate. If you have a web camera, please do NOT use it.
  - **Note:** If you cannot download or run the application, you will be provided an option to join from your browser.
- Make sure your computer or tablet has the minimum system requirements: **Join a test meeting**

If you have any questions about join a Zoom meeting, please contact, <researcher name> at <XXX-XXX-XXXX>.

# Focus Group Discussion Reference Guide

## Scenario 1:

How accurately did we capture the procedures associated with this scenario?

Is there anything that you would do differently?

Are there steps or interactions that we missed entirely?

How might your procedures and vehicle interactions change based on:

- The weather?
- Roadway type?
- Roadway geometry?
- Geography/location?
- Vehicle type (for example, a small vehicle versus a tractor-trailer)?

## Scenario 2:

How accurately did we capture the procedures associated with this scenario?

Is there anything that you would do differently?

Are there steps or interactions that we missed entirely?

How might your procedures and vehicle interactions change based on:

- The weather?
- Roadway type?
- Roadway geometry?
- Geography/location?
- Vehicle type (for example, a small vehicle versus a tractor-trailer)?

## Scenario 3:

How accurately did we capture the procedures associated with this scenario?

Is there anything that you would do differently?

Are there steps or interactions that we missed entirely?

How might your procedures and vehicle interactions change based on:

- The weather?
- Roadway type?
- Roadway geometry?
- Geography/location?

Vehicle type (for example, a small vehicle versus a tractor-trailer)?

## A.4 Focus Group Informed Consent Form

**VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY**

***Virginia Tech Transportation Institute Online Public Safety Study Focus Group Informed Consent Information for Participants in Research Projects Involving Human Subjects***

**Title of Research Study:** Support Services Small Group Interviews
**Investigators:** Travis Terry, Tammy Trimble, Robin Riessman

### I. THE PURPOSE OF THIS RESEARCH STUDY

This joint VTTI and University of Massachusetts-Amherst's Traffic Safety Research Program (UMASS) study will use focus groups and one-on-one interviews to assess the protocols of public safety organizations. Specifically, this study will examine how law enforcement officers, fire fighters, and other first responders interact with non-emergency vehicles on public roadways. The purpose of this focus group will be (1) to better understand your responsibilities and how you potentially interact with non- emergency vehicles and (2) to explore whether changes to the environment, circumstances, personnel, or technology impact those interactions. Up to 5 other people like you may participate in this focus group.

### II. PROCEDURES

The web-based focus group will last a maximum of 125 minutes (2 hours, 5 minutes) and will be audio- recorded. The focus group is an informal discussion group where you will share your thoughts and opinions on some operational procedures and scenarios. During the course of the focus group you will:

1. Be asked to log into the online focus group session and connect to the audio portion of the focus group via the hosting site's (i.e., Zoom's or GoToMeeting's) voice over internet protocol (VOIP) or a telephone.
2. Be reminded of the information in this informed consent and provided with an opportunity to discuss any questions or concerns you have with a researcher.
3. Provide verbal consent to participate and to be audio recorded.
4. Listen to a brief description of the research study after which you will be asked to provide your opinions and feedback on a number of operational scenarios that may include, but are not limited to responding to an incident, securing the scene, and traffic direction and control.

### III. RISKS

There is minimal risk involved in this study. The minimal risks include: possible minor discomfort from expressing your opinions in front of others in a focus group setting.

## IV. BENEFITS

No promise or guarantee of benefits is made to encourage you to participate. Your opinions and perceptions may influence the development of future transportation-related policy initiatives.

## V. EXTENT OF ANONYMITY AND CONFIDENTIALITY

The data gathered in this experiment will be treated with confidentiality. Coding (i.e., Participant 1 = #0001) will be used so participant names will not be linked with any data collected. Data that identifies you will not be shared with anyone besides the joint VTTI-UMASS key research team members. Data that is reported or shared with any outside group or people will be in summary form so that your participation will remain confidential.

The focus group will be audio-recorded. The data from this study will be stored at VTTI. The audio recordings will be destroyed after they are transcribed (turned into a written document).

It is possible that the Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human subjects involved in research. Access to the data will be under the supervision of Travis Terry and Tammy Trimble (VTTI), and Robin Riessman (UMASS).

## VI. COMPENSATION

No monetary compensation will be provided.

## VII. FREEDOM TO WITHDRAW

As a voluntary participant in this study, you are free to withdraw from this study at any time without penalty. You are free not to answer any questions that you choose or respond to what is being asked of you without penalty.

## VIII. APPROVAL OF RESEARCH

This research study has been approved, as required, by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University. This approval is good for the period of time listed on the bottom of this page.

## IX. PARTICIPANT'S RESPONSIBILITIES

If you voluntarily agree to participate in this study, you will have the following responsibilities:

- To participate fully in the focus group discussion and to notify the experimenter of any concerns or questions that may arise during the course of the focus group session.

## X. QUESTIONS AND CONCERNS

Should you have any questions about this research you may contact:

| | | |
|---|---|---|
| Travis Terry, Project Manager | 540-231-3955 | tterry@vtti.vt.edu |
| Tammy Trimble, Focus Group Coordinator | 540-231-1036 | ttrimble@vtti.vt.edu |
| Robin Riessman, Focus Group Coordinator | 413-577-1035 | riessman@ecs.umass.edu |

Should you have any questions or concerns about the study's conduct or your rights as a research subject or need to report a research-related injury or event, you may contact the Virginia Tech IRB at 540-231-3732 or irb@vt.edu.

## XI. PARTICIPANT'S PERMISSION – VERBAL CONSENT

By providing verbal consent at the beginning of the focus group, you will be indicating that:

- You have read and understand the requirements, procedures, and conditions of this study.
- You have had all of your questions about the nature of the study answered.
- You are voluntarily agreeing to have your voice recorded during the focus group.
- You understand that you may withdraw from this study at any time without penalty.

# Appendix B: One-on-One Interview Recruitment

## B.1 One-on-One Interview Recruitment Call Script

**Note:** Initial contact between participants and researchers may take place over the phone or via email. If taking place via phone, read the following Introductory Statement followed by the questionnaire.

**Introductory Statement:**
After prospective participant calls or you call them, use the following script as a guideline

*Hello. My name is _____ and I'm with [the Virginia Tech Transportation Institute, in Blacksburg, VA,* ***<or the University of Massachusetts-Amherst's Traffic Safety Research Program in Amherst, Massachusetts>.*** *We are currently working on a research study sponsored by a consortium of automakers to assess the protocols of public safety organizations. Specifically, this study will examine how law enforcement officers, fire fighters, and other first responders interact with non-emergency vehicles on public roadways. We are also looking at how these interactions may vary across jurisdictions and over time.*

*This study includes an in-depth review of protocols associated with several operational scenarios, such as, responding to an incident, securing a scene, and traffic direction and control. To that end, we are seeking the input of experts from a number of public safety organizations such as yours. We realize your time is valuable. However, your involvement is important to the success of this research study and may help to shape future transportation policy-related decisions.*

*I would like to invite you to participate in an online interview discussion. The purpose of this discussion will be (1) to better understand your responsibilities and how you potentially interact with non-emergency vehicles, and (2) to explore whether changes to the environment, circumstances, personnel, or technology impact those interactions. During the interview, we will ask for your thoughts and opinions on some materials and operational procedures. All information shared during the interview will be kept confidential. Your participation would be voluntary; no monetary compensation is provided. Total participation time will be one session lasting approximately 90 minutes (1.5 hours). Please note that all interview sessions will be audio recorded.*

*Any questions yet? Are you interested in participating?*

*[If not interested] Do you know of any colleagues in [jurisdiction, state] who may be interested in participating?*

- *[if yes] Great! You can forward them my contact information or if you feel comfortable providing me their contact information, that works too.*
- *[if no]* Thank them for their time.

*If you are interested in participating, I need to go over some screening questions. Your responses will be used to determine eligibility and aggregated responses will be included in the final report to summarize our recruitment efforts. Any information given to us will be kept secure and confidential.*

*Do I have your consent to ask the screening questions? [If yes, continue with the questions. If no, then thank him/her for their time and end the phone call.]*

**Screening Questions**

- How many years of experience do you have as a public safety officer or first responder? _____ What is the title and number of years for each position held (all positions)?
  _____
  _____
  _____
  What is your current position? _____
  *Criterion: Must have served or currently serving as a public safety officer or first responder.*

- In terms of number of individuals, what is the size of your police force/fire department/EMS unit/organization? _____
  *Criterion: Any size is eligible*

- [For fire and rescue and EMS] Is your department paid, volunteer, or a combination of paid and volunteer?
  _____
  If both, what percentage is paid? _____ Volunteer? _____
  *Criterion: Doesn't affect eligibility.*

- Do you have access to a computer, tablet, or smartphone with internet service?
  Yes _____ No _____
  *If yes*, does your computer/device have a microphone and speakers in order for you to join the study session using an online conferencing link we will send to you?
  Yes _____ No _____
  *If no, would you be willing to connect to the session using your telephone?*
  Yes _____ No _____
  *If yes*, do you have an email address where we can send you an Informed Consent Form to review, and a link to connect to the online study session?
  Yes _____ No _____
  *If yes*, are you willing to follow the link and on-line invitation to join a scheduled interview discussion? This will require you to use your computer or tablet and/or a telephone for the entire length of the session, about **1.5** hours?
  Yes _____ No _____
  *If connecting via tablet or smartphone, you may need to install an app to connect. Would you be willing to install the [Zoom app/GoToMeeting app] if necessary*?
  Yes _____ No _____
  Note: a camera is not needed and if they have a camera on their computer/device they will be asked NOT to use it.
  *Criterion: Must have access to email. Must be willing to connect to the video portion of the session via Internet-enabled computer, tablet, or smartphone for entire length of session. Must be willing to connect to audio portion of session via computer or tablet microphone and speaker or a telephone for the entire*

*length of the scheduled study session. If connecting to video via a smartphone or tablet, must be willing to install a mobile app if necessary. Note: If connecting via computer, an option to join from a web browser is provided so installation of an app is not required.*

If yes to all the above, "You are eligible for the study; may I please have your email address": _____

**If Willing to Participate Schedule Interview Time.**
We have scheduled interview sessions for:

- **[Include multiple date/time options here]**

Would one of these sessions fit your schedule?

If none of these times work for you, are there other times that you know you are available?
**Determine if another session is available that fits their schedule.**
*[If none] Do you know of any colleagues in [jurisdiction, state] who may be interested in participating?*

- *[if yes] Great! You can forward them my contact information or if you feel comfortable providing me their contact information, that works too.*
- *[if no]* Thank them for their time.

We are interested in reaching out to a number of organizations with a focus on **<description, e.g., training first responders>**. Do you have colleagues **< at another organization with a similar focus as yours>** who may be willing to participate in our study?

If yes to all the above, "would you mind forwarding the study details and my contact information on to them? Or if you prefer I can contact them myself, if you are comfortable giving me their contact information." _____

**If a time has been scheduled:**
*Thank you. We have you scheduled for [Date, Time]. I will be sending you an invitation with instructions for joining the on-line study session. In addition, I will be sending you the informed consent form that reviews the information that we discussed and provides additional details and a discussion guide that we will refer to during out discussion. Please take time to review this information prior to the scheduled interview. If you do not receive our email or have any questions, please call us at XXX-XXX-XXXX. Again that number is XXX-XXX-XXXX and please refer to the "Blue" Study in your message.*

*[If more participants required] I have one last question to ask before we end the call. Are you aware of any [colleague type (fire fighter, EMT, law enforcement)] who may also be interested in participating from [jurisdiction, state]?*

- *[if yes] Great! You can forward them my contact information or if you feel comfortable providing me their contact information, that works too.*
- *[if no]* Thank them for their time.

## B.2 One-on-One Interview Recruitment E-mail

**Note:** Initial contact between participants and researchers may take place over the phone or via email. If taking place via email, use the following introductory letter.

Subject: Invitation to participate in joint VTTI and UMASS Public Safety Study

Dear **[NAME]:**

The Virginia Tech Transportation Institute in cooperation with the University of Massachusetts-Amherst's Traffic Safety Research Program are currently working on a research study sponsored by a consortium of vehicle manufacturers to assess the protocols of public safety organizations, for example, police officers, fire fighters, first responders, etc. Specifically their interactions with non-emergency vehicles on public roadways. We are also looking at how these interactions may vary across jurisdictions and over time.

This study includes an in-depth review of protocols associated with several operational scenarios, such as such as, responding to an incident, securing a scene, and traffic direction and control. To that end, we are seeking the input of experts from a number of public safety organizations such as yours. We realize your time is valuable. However, your involvement is important to the success of this research study and may help to shape future transportation policy-related decisions.

I would like to invite you, or one of your similarly qualified colleagues at either your own or a collaborating institution, to participate in an online interview discussion. The purpose of this discussion will be (1) to better understand first responders' responsibilities and how they potentially interact with non-emergency vehicles and (2) to explore whether changes to the environment, circumstances, personnel, or technology impact those interactions.

During the interview, we will ask for your thoughts and opinions on some materials and operational procedures. The discussion will be one session lasting approximately 90 minutes (1.5 hours) during daytime or early evening hours. Please note that all interviews will be audio recorded. All information shared during the interview will be kept confidential. Further, your participation would be voluntary; no monetary compensation is provided. However, your opinions and perceptions may influence the development of future transportation-related policy initiatives.

I would be happy to provide you with additional details about this request for assistance. Please feel free to contact me at [number] or [email].

Sincerely,

**Name, Title**

## B.3 One-on-One Interview Confirmation E-mail

Subject: Confirmation for VTTI/UMASS Public Safety Study

Dear [Name]:

Thank you for agreeing to participate in an online interview that is being conducted by the Virginia Tech Transportation Institute in cooperation with the University of Massachusetts-Amherst's Traffic Safety Research Program on behalf of a consortium of automakers. As part of this research study, we are assessing the protocols of public safety organizations. Specifically, this study will examine how law enforcement officers, fire fighters, and other first responders interact with non-emergency vehicles on public roadways. We are also looking at how these interactions may vary across jurisdictions and over time.

The purpose of this interview will be (1) to better understand first responders' responsibilities and how they potentially interact with non-emergency vehicles and (2) to explore whether changes to the environment, circumstances, personnel, or technology impact those interactions. During the interview, we will ask for your thoughts and opinions on some materials and operational procedures.

**Interview Process**

Your interview is scheduled for **[DATE, TIME]** and will run for approximately 90 minutes (1.5 hours). Please log into the interview using the following information **[Include Zoom/GoToMeeting Information Here]**. Additional **[Zoom or GoToMeeting]** information is included below for your reference.

During the course of the interview you will:

- Be asked to log into the online interview session and connect to the audio portion of the interview via the hosting site's (i.e., Zoom's or GoToMeeting's) voice over internet protocol (VOIP) or a telephone.
- Be reminded of the information included within the attached Informed Consent Form. Please review this information prior to our session. You will be provided an opportunity to discuss any questions or concerns you have with a researcher.
- Provide verbal consent to participate in the study and to be audio recorded.
- Listen to a brief description of the research study after which you will be asked to provide your opinions and feedback on a number of operational scenarios that may include, but are not limited to responding to an incident, securing the scene, or traffic direction and control.

In order to facilitate the free flow of conversation, prior to beginning our discussion, we will ask for your permission to audio record our conversation. The audio recordings will be used to supplement our handwritten notes. Should you decline to grant your permission to be recorded, we will ask you to log off of the call.

To further facilitate the discussion, we have attached a list of questions that will be guiding our discussion. We encourage you to use this list to take notes during our discussion.

**Confidentiality**

- Individual responses will be aggregated for reporting purposes, and general information (e.g., police officer, fire chief, etc.), not individuals, will be referenced in the research reports. Should you agree to have our discussion recorded, your name will not be associated with your transcript.

- The audio recordings will be deleted upon completion of the transcription process; however, the researchers and the study sponsors will retain copies of the transcripts. Again, all personally identifying information will be redacted from the transcripts.
- It is possible that the Virginia Tech Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human participants involved in research.

You are free to withdraw from this study at any time or decline to answer any questions that you choose. Should you have any questions about this study, you may contact:

| | | |
|---|---|---|
| Travis Terry | 540 231-3955 | tterry@vtti.vt.edu |
| Tammy Trimble, Ph.D. | 540-231-1036 | ttrimble@vtti.vt.edu |
| Robin Riessman | 413-577-1035 | riessman@ecs.umass.edu |

Should you have any questions or concerns about the study's conduct or your rights as a research subject or need to report a research-related event, you may contact the Virginia Tech IRB at 540-231-3732 or irb@vt.edu.

We appreciate your willingness to share your experience with us and look forward to talking with you further about this exciting research study.

Sincerely,

**Name, Title**
**Email | Phone**

Attachments: Informed Consent Form. Interview Discussion Questions

**Zoom User Information**

- View a short video explaining how to join a Zoom meeting: **Attend a meeting**
  - **Note:** We will not be using the video option available through Zoom. You **do not need** a web camera to participate. If you have a web camera, please do NOT use it.
  - **Note:** If you cannot download or run the application, you will be provided an option to join from your browser.
- Make sure your computer or tablet has the minimum system requirements: **Join a test meeting**

If you have any questions about join a Zoom meeting, please contact, <researcher name> at <XXX-XXX-XXXX>.

# Interview Discussion Reference Guide

## Scenario 1:

How accurately did we capture the procedures associated with this scenario?

Is there anything that you would do differently?

Are there steps or interactions that we missed entirely?

How might your procedures and vehicle interactions change based on:

- The weather?
- Roadway type?
- Roadway geometry?
- Geography/location?
- Vehicle type (for example, a small vehicle versus a tractor-trailer)?

## Scenario 2:

How accurately did we capture the procedures associated with this scenario?

Is there anything that you would do differently?

Are there steps or interactions that we missed entirely?

How might your procedures and vehicle interactions change based on:

- The weather?
- Roadway type?
- Roadway geometry?
- Geography/location?
- Vehicle type (for example, a small vehicle versus a tractor-trailer)?

## Scenario 3:

How accurately did we capture the procedures associated with this scenario?

Is there anything that you would do differently?

Are there steps or interactions that we missed entirely?

How might your procedures and vehicle interactions change based on:

- The weather?
- Roadway type?
- Roadway geometry?
- Geography/location?
- Vehicle type (for example, a small vehicle versus a tractor-trailer)

## B.4 One-on-One Informed Consent Form

**VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY**

***Virginia Tech Transportation Institute Online Public Safety Study***
***Interview Informed Consent Information for Participants in Research Projects Involving Human Subjects***

**Title of Research Study:** Support Services Small Group Interviews
**Investigators:** Travis Terry, Tammy Trimble, Robin Riessman

### I. THE PURPOSE OF THIS RESEARCH STUDY

This joint VTTI and University of Massachusetts-Amherst's Traffic Safety Research Program (UMASS) study will use focus groups and one-on-one interviews to assess the protocols of public safety organizations. Specifically, this study will examine how law enforcement officers, fire fighters, and other first responders interact with non-emergency vehicles on public roadways. The purpose of this interview will be (1) to better understand your responsibilities and how you potentially interact with non- emergency vehicles and (2) to explore whether changes to the environment, circumstances, personnel, or technology impact those interactions.

### II. PROCEDURES

The web-based interview will last a maximum of 90 minutes (1 hour, 30 minutes) and will be audio-recorded. The interview is an informal discussion where you will share your thoughts and opinions on some operational procedures and scenarios. During the course of the interview you will:

1. Be asked to log into the online interview session and connect to the audio portion of the interview via the hosting site's (i.e., Zoom's or GoToMeeting's) voice over internet protocol (VOIP) or a telephone.
2. Be reminded of the information in this informed consent and provided with an opportunity to discuss any questions or concerns you have with a researcher.
3. Provide verbal consent to participate and to be audio recorded.
4. Listen to a brief description of the research study after which you will be asked to provide your opinions and feedback on a number of operational scenarios that may include, but are not limited to responding to an incident, securing the scene, and traffic direction and control.

### III. RISKS

There is minimal risk involved in this study. The minimal risks include: possible minor discomfort from expressing your opinions in an interview setting.

### IV. BENEFITS

No promise or guarantee of benefits is made to encourage you to participate. Your opinions and perceptions may influence the development of future transportation-related policy initiatives.

## V. EXTENT OF ANONYMITY AND CONFIDENTIALITY

The data gathered in this experiment will be treated with confidentiality. Coding (i.e., Participant 1 = #0001) will be used so participant names will not be linked with any data collected. Data that identifies you will not be shared with anyone besides the joint VTTI-UMASS key research team members. Data

that is reported or shared with any outside group or individuals will be in summary form so that your participation will remain confidential.

The interview will be audio-recorded. The data from this study will be stored at VTTI. The audio recordings will be destroyed upon completion of the transcription process (turned into a written document); however, the researchers and project sponsors will retain copies of the transcripts.

It is possible that the Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human subjects involved in research. Access to the data will be under the supervision of Travis Terry and Tammy Trimble (VTTI), and Robin Riessman (UMASS).

## VI. COMPENSATION

No monetary compensation will be provided.

## VII. FREEDOM TO WITHDRAW

As a voluntary participant in this study, you are free to withdraw from this study at any time without penalty. You are free not to answer any questions that you choose or respond to what is being asked of you without penalty.

## VIII. APPROVAL OF RESEARCH

This research study has been approved, as required, by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University. This approval is good for the period of time listed on the bottom of this page.

## IX. PARTICIPANT'S RESPONSIBILITIES

If you voluntarily agree to participate in this study, you will have the following responsibilities:

- To participate fully in the interview discussion and to notify the experimenter of any concerns or questions that may arise during the course of the interview session.

## X. QUESTIONS AND CONCERNS

Should you have any questions about this research you may contact:

| | | |
|---|---|---|
| Travis Terry, Project Manager | 540-231-3955 | tterry@vtti.vt.edu |
| Tammy Trimble, Interview Coordinator | 540-231-1036 | ttrimble@vtti.vt.edu |
| Robin Riessman, Interview Coordinator | 413-577-1035 | riessman@ecs.umass.edu |

Should you have any questions or concerns about the study's conduct or your rights as a research subject or need to report a research-related injury or event, you may contact the Virginia Tech IRB at 540-231-3732 or irb@vt.edu.

## XI. PARTICIPANT'S PERMISSION – VERBAL CONSENT

By providing verbal consent at the beginning of the interview, you will be indicating that:

- You have read and understand the requirements, procedures, and conditions of this study.
- You have had all of your questions about the nature of the study answered.
- You are voluntarily agreeing to have your voice recorded during the interview.
- You understand that you may withdraw from this study at any time without penalty?

# Appendix C: Hierarchical Task Analysis (HTA)

## C.1 Respond to an Incident

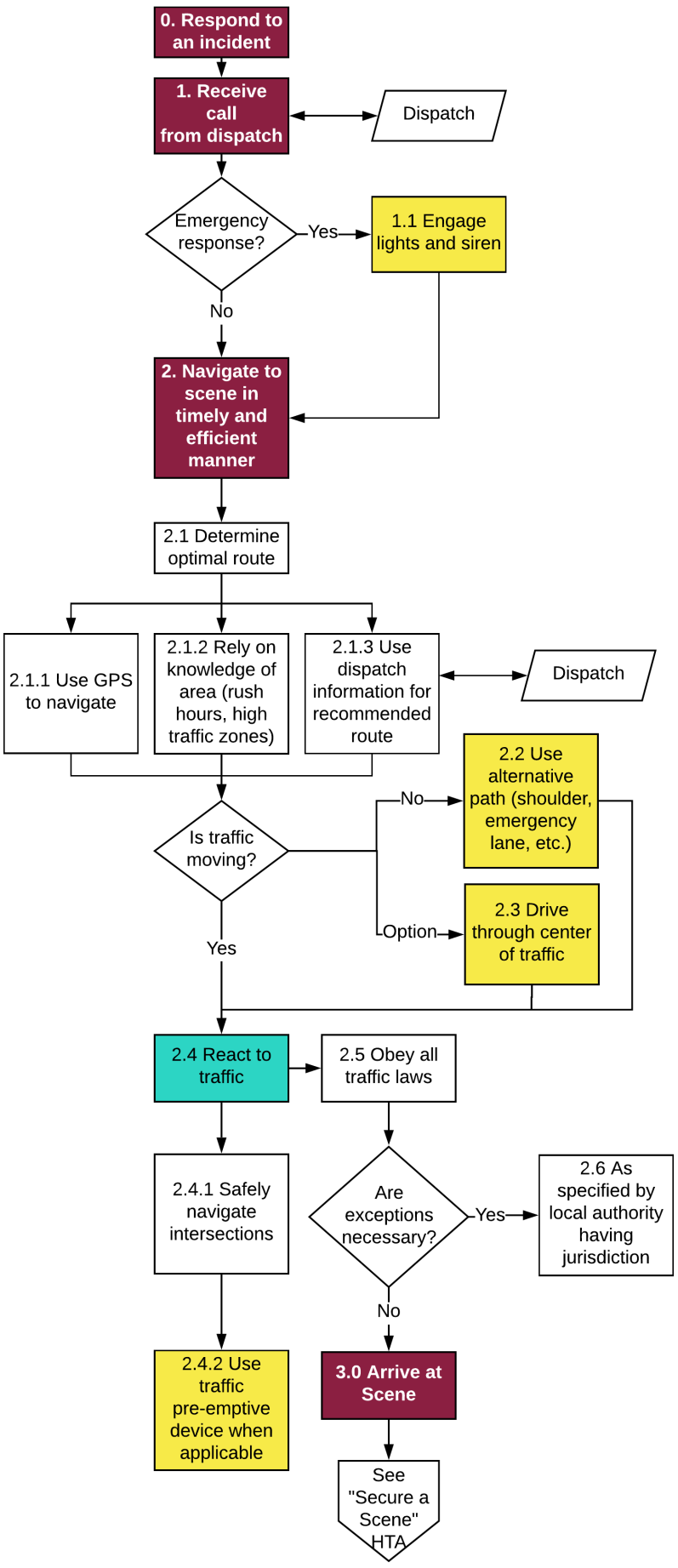



**Figure 66. Full HTA for Respond to Incident.**

## C.2 Secure a Scene

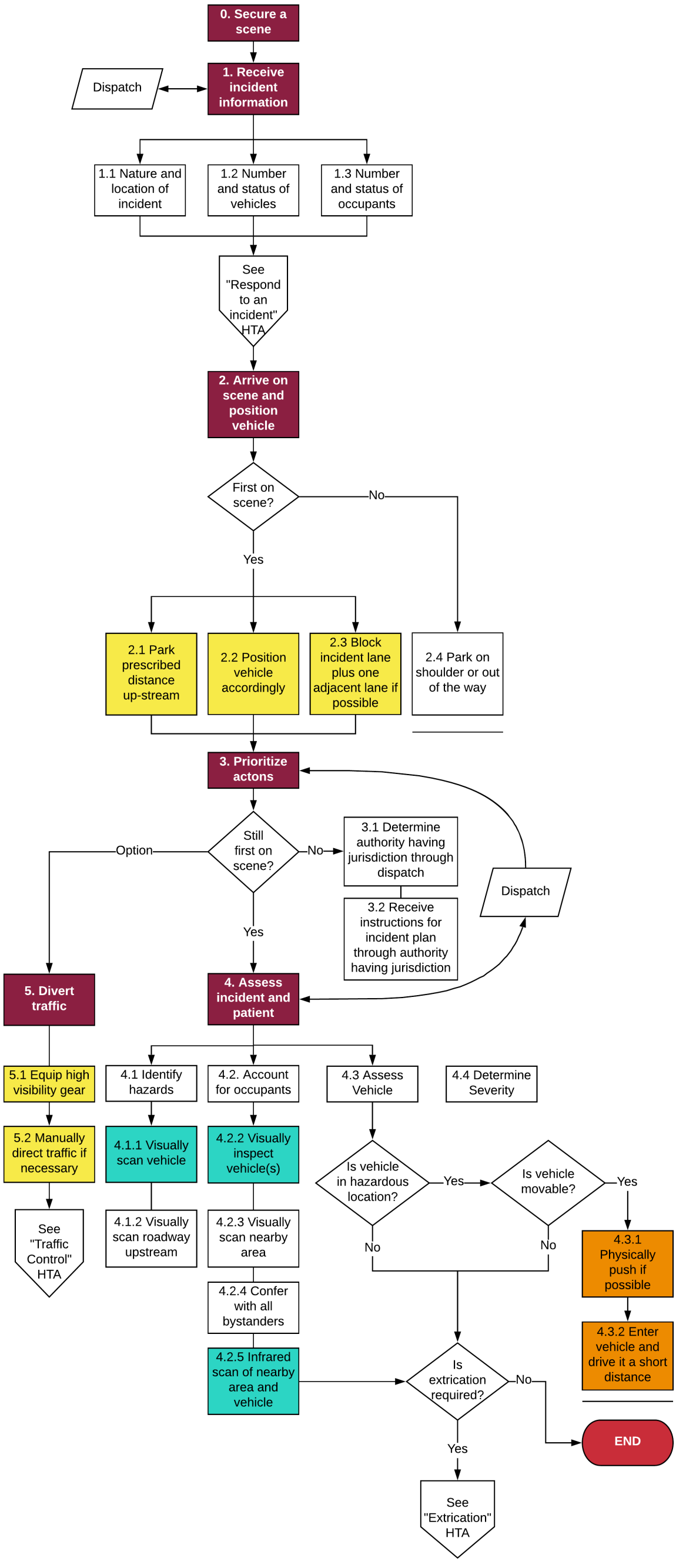



**Figure 67. Full HTA for Secure a Scene.**

## C.3 Traffic Direction and Control

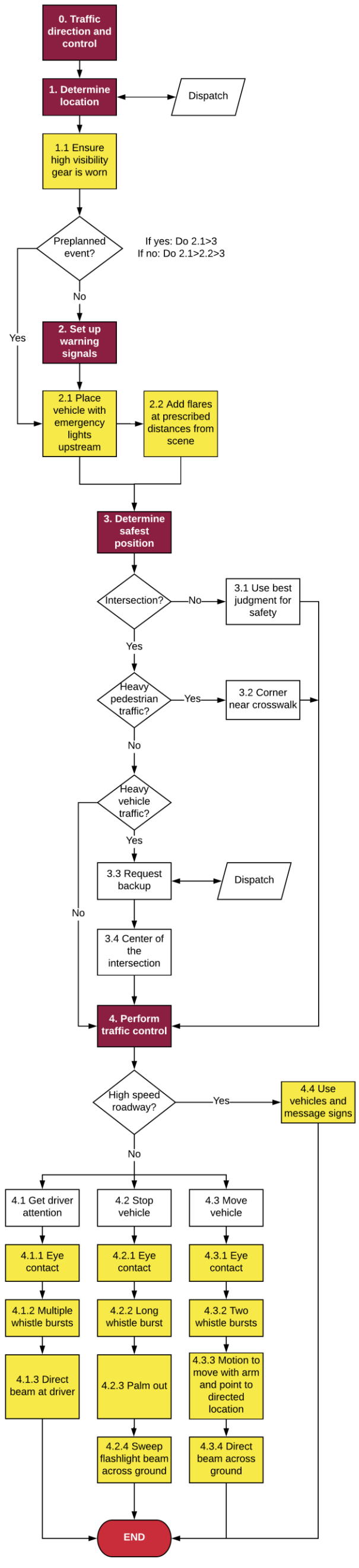



**Figure 68. Full HTA for Traffic Direction and Control.**

## C.4 Complete Traffic Stop

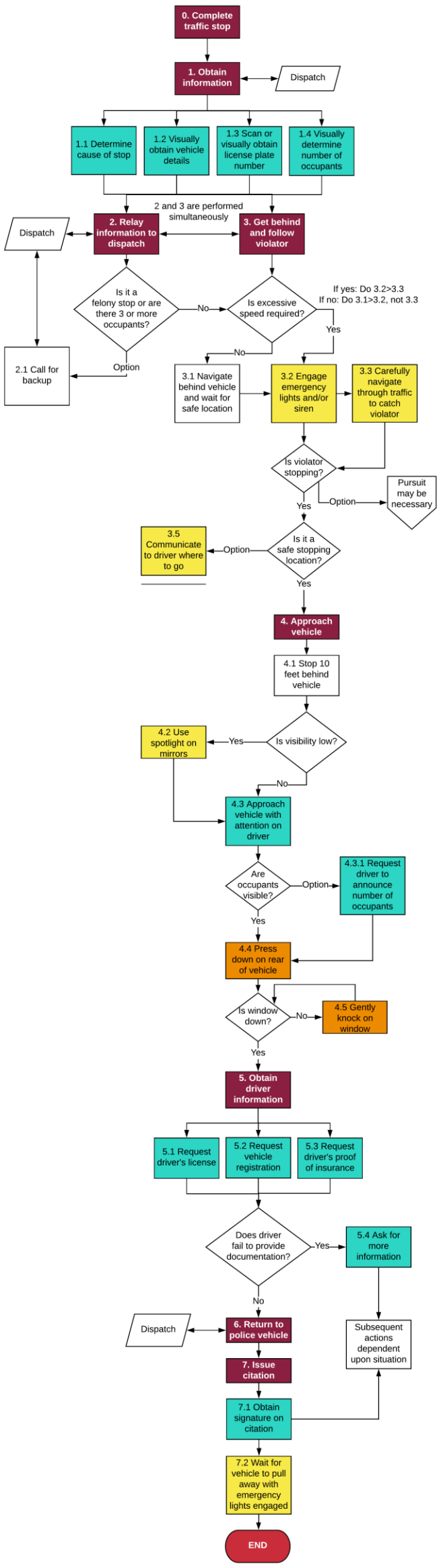



**Figure 69. Full HTA for Complete Traffic Stop.**

## C.5 Assist Motorist

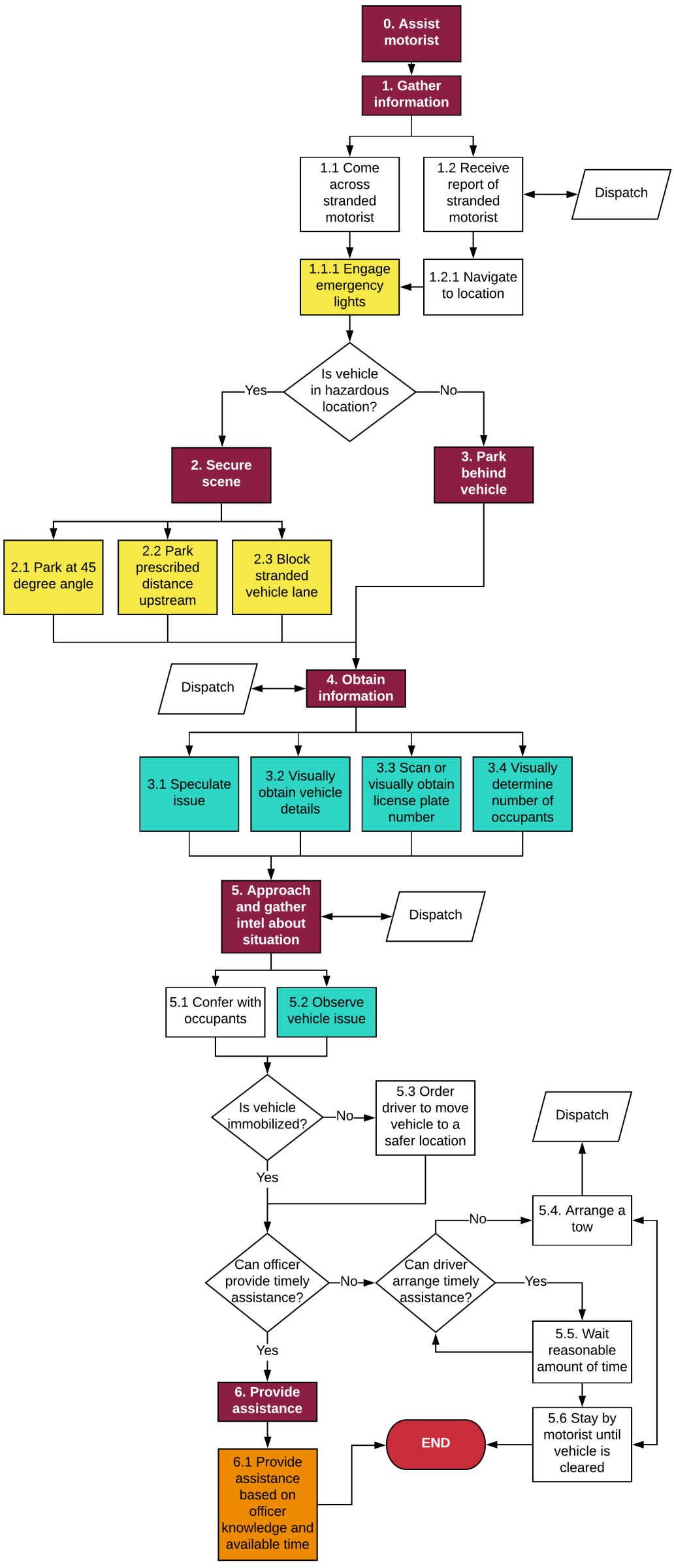



**Figure 70. Full HTA for Assist Motorist.**

## C.6 Address Abandoned Vehicle

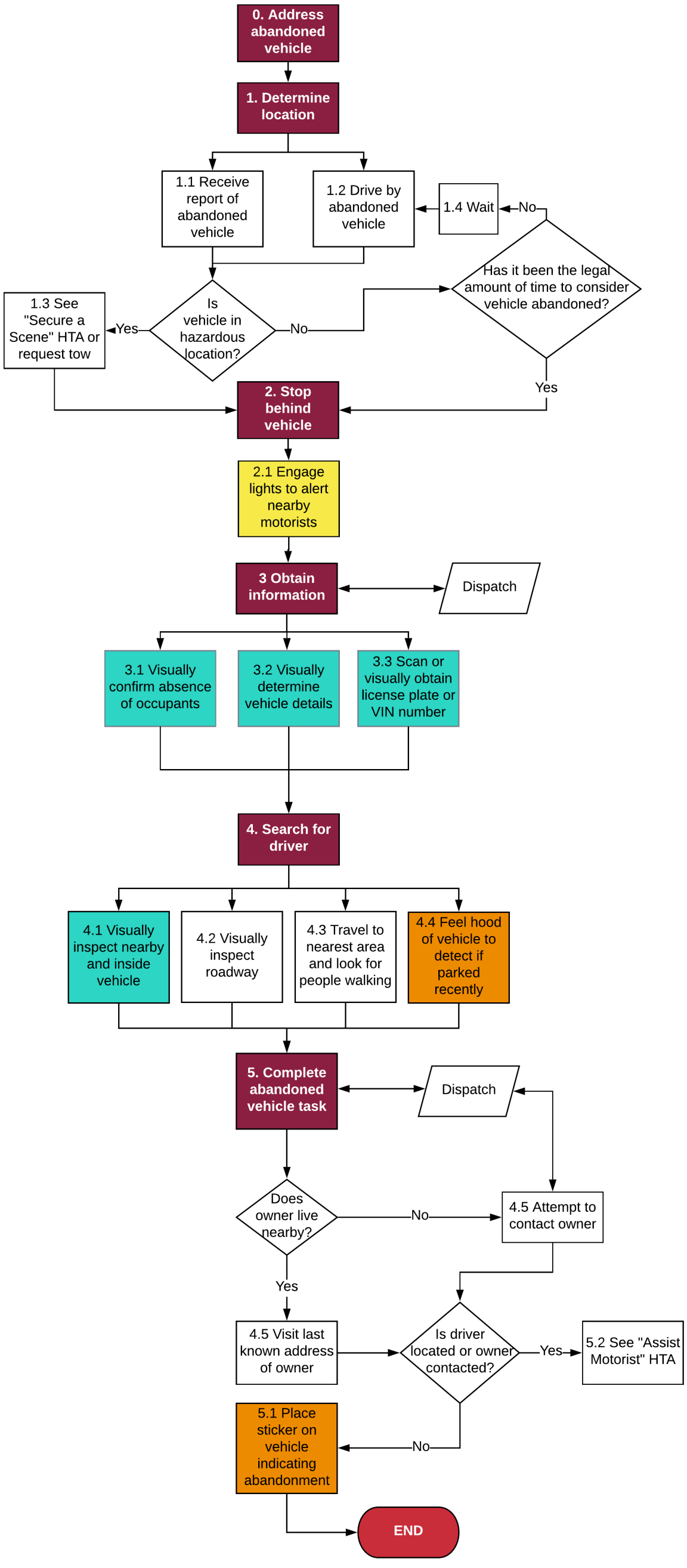



**Figure 71. Full HTA for Address Abandoned Vehicle.**

## C.7 Conduct Checkpoint

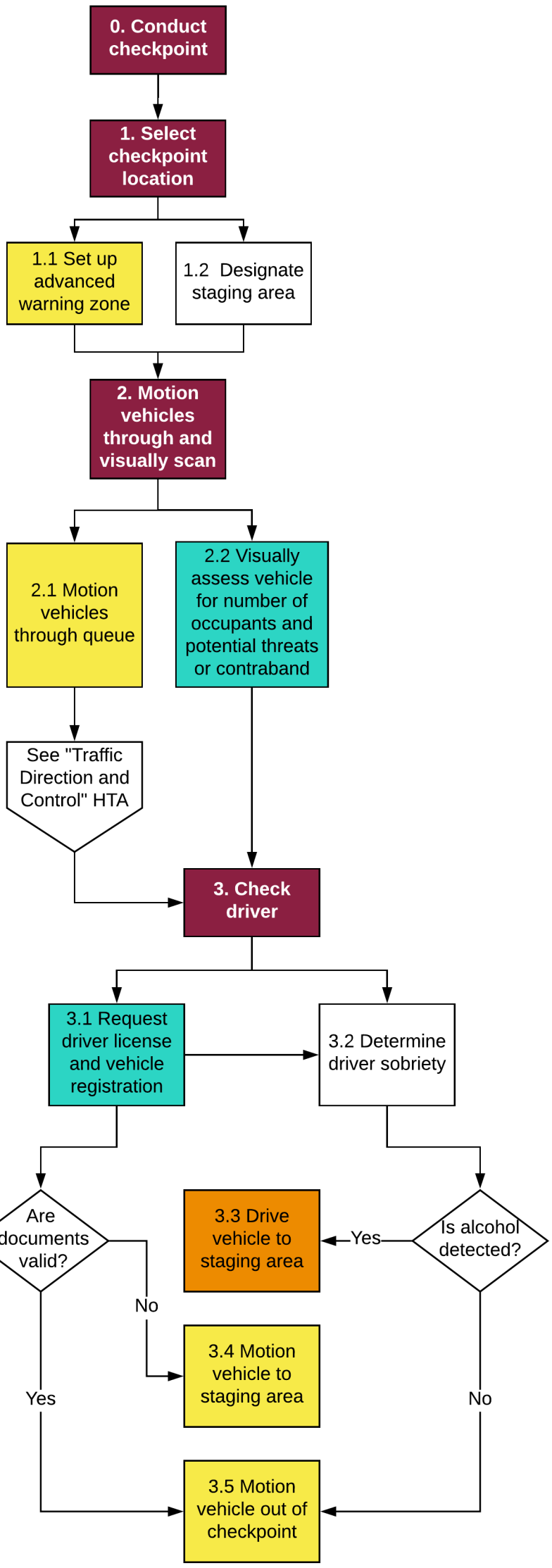



**Figure 72. Full HTA for Conduct Checkpoint.**

## C.8 Extricate Occupant

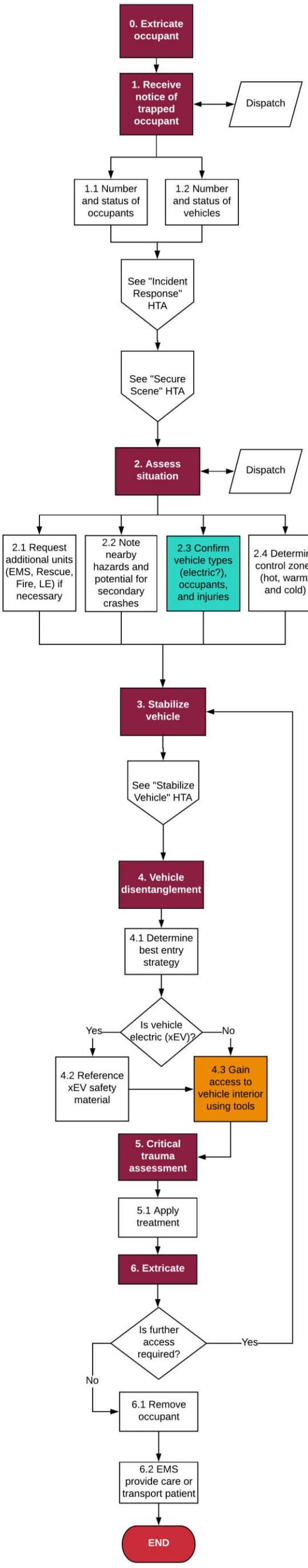



**Figure 73. Full HTA for Extricate Occupant.**

## C.9 Stabilize Vehicle

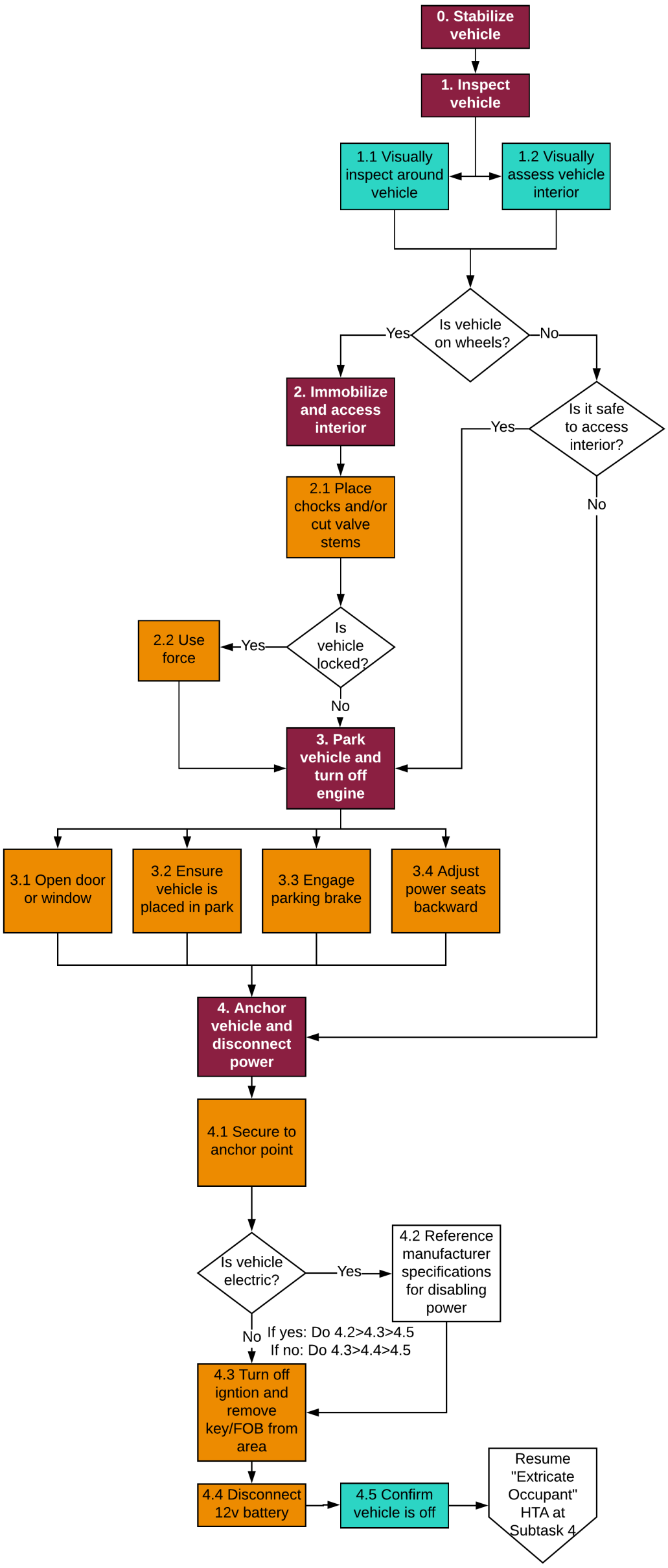



**Figure 74. Full HTA for Stabilize Vehicle.**

# Appendix D: New Findings to Current Operations

### Table 47. New Findings to Current Operations (Part 1)

| Item No. | Responding to Incident | LE | FR | EMS |
|---|---|---|---|---|
| 1 | Emergency vehicle's may turn off lights and sirens in some scenarios | 9 | 1 | 4 |
| 2 | Use of air horns | 1 | 2 | 2 |
| 3 | May respond using different vehicle types (ATV, SUV, all-wheel drive) | 5 | | |
| 4 | Rural departments may respond in personal vehicles | | | 2 |
| 5 | Traffic patterns or time of day may impact route | 5 | | |
| 6 | Make eye contact with other drivers at intersections | 3 | | 2 |
| 7 | May access sidewalk | 1 | | |
| 8 | If not first, may proceed with less urgency | 1 | | 1 |
| 9 | Known hazmat may result in slower response | 1 | | |
| 10 | Hazards may heighten response (downed power lines, spills) | 5 | | |
| 11 | May drive into oncoming lane | 1 | | 1 |
| 12 | May drive through roundabouts or traffic circles if able | | | 2 |
| 13 | Rural areas must be aware of slow moving farm equipment | 1 | | |
| 14 | Increase following distance in inclement weather | 1 | | |
| 15 | Unmarked vehicles are less identifiable and less visible | 15 | | |
| **Item No.** | **Securing a Scene** | **LE** | **FR** | **EMS** |
| 16 | EMS may remove patients prior to LE or Fire arrival | | | 1 |
| 17 | May respond to injuries without scene protection | 1 | | 1 |
| 18 | Larger vehicles or more vehicles result in longer operation durations | 11 | | |
| 19 | Political pressures may rush operations | 1 | | |
| 20 | May surround a scene with police tape | 1 | | |
| 21 | Investigate the cause of a crash | 3 | 1 | |
| 22 | "Size up" scene to verify information from dispatch | 5 | 1 | 1 |
| 23 | Make room for helicopter to land | 1 | | |
| 24 | Time of day may impact number of resources available | 1 | | |
| 25 | May stop passer-by to assist with traffic control at a scene in rural area | | | 1 |
| 26 | May notify public of an accident or detour via social media | 1 | | |
| **Item No.** | **Traffic Direction and Control** | **LE** | **FR** | **EMS** |
| 27 | Considerations for how to detour traffic consists of several factors | 11 | 5 | 4 |
| 28 | Urban areas have more available reroute options available | | | 1 |
| 29 | May have to park large vehicles that cannot turn around if road closes | 8 | | |
| 30 | May ask larger vehicle what maneuver it is capable of before directing it | 1 | | |
| 31 | Worn equipment varies in terms of visibility | 2 | 3 | 1 |
| 32 | During low temperatures, worn equipment varies in favor of warmth | 3 | | |
| 33 | Flare positioning not regulated | 1 | | |
| 34 | Use of LED devices instead of flares | 7 | 2 | |
| 35 | Advanced warnings depend on available resources | 3 | | 1 |

| | | | | |
|---|---|---|---|---|
| 36 | Use of a vehicle to protect or barricade self when conducting traffic | | 5 | |
| 37 | Rely on message boards and signage instead of people on high speed roadways for traffic control | 5 | | |
| 38 | Use of rumble strips to slow traffic | | | 1 |
| 39 | May abandon operation in severe weather and retreat to a vehicle | 2 | | |
| 40 | Hand signals vary person to person | 1 | | |
| 41 | Flashlights with covers to convert into a traffic wand | 3 | 1 | |
| 42 | Would not shine flashlight at a driver | 1 | | |
| 43 | Make an X with light wands to stop a vehicle | | 1 | |
| 44 | Drivers may stop to ask a traffic controller for clarification or additional navigation directions | 1 | | |

**Table 48. New Findings to Current Operations (Part 2)**

| Item No. | Traffic Stops | LE | FR | EMS |
|---|---|---|---|---|
| 45 | Compacted snow may impact visibility of license plate | 2 | | |
| 46 | Number of stops may be reduced if circumstances or weather make the operation unsafe | 25 | | |
| 47 | Will reduce number of stops in inclement weather to prevent secondary crashes | 15 | | |
| 48 | May ask drivers of large trucks to step out or shut off engine prior to approaching | 5 | | |
| 49 | May need to veer into adjacent lane for driver of large truck to see | 2 | | |
| | May ask drivers to verbally report number of occupants prior to report or drive beside vehicle to peer inside to count occupants | 2 | | |
| 50 | SUVs and Unmarked vehicles are less identifiable and less visible | 6 | | |
| 51 | Will ask driver to roll down tinted windows | 2 | | |
| 52 | May ride beside vehicle to visually obtain number of occupants prior to stop | 1 | | |
| 53 | May pull onto roadway with lights and sirens for driver to reenter | 3 | | |
| **Item No.** | **Abandoned or Unattended Vehicle** | **LE** | **FR** | **EMS** |
| 54 | Some areas have no time limit and can tow immediately | 2 | | |
| 55 | Police may investigate vehicle with hazard lights or parked suspiciously | 2 | | |
| 56 | May wait for occupants of an unattended vehicle to return to vehicle or may ignore it completely | 2 | | |
| 57 | May use spray paint or chalk to mark abandoned vehicle or place an abandoned tag in plastic | 3 | | |
| 58 | Statewide tow log minimize stolen vehicle reports | 1 | | |
| 59 | Laws regarding abandoned vehicles on private property vary | 13 | | |
| 60 | Do not tow for fire lanes, must have a complaint first | 1 | | |
| 61 | Out of date registration requires immediate tow | 2 | | |
| 62 | May not investigate a vehicle until weather clears | 2 | | |
| 63 | Parking zones may change seasonally or yearly or denoted with signs | 1 | | |
| 64 | Ordinances often dictate specific rules for toll roads and street parking | 2 | | |
| 65 | May not use emergency lights or advanced warnings when investigating abandoned vehicle | 2 | | |
| 66 | May use backup or advanced warning devices to investigate abandoned vehicle in low visibility area | 3 | | |
| 67 | Will use VIN number to verify registration information on abandoned vehicle | 2 | | |
| 68 | May not search for driver if time does not allow | 4 | | |
| 69 | May identify the load of a cargo vehicle for security | 1 | | |
| 70 | May lax time limit if owner plans to move it soon | 1 | | |
| **Item No.** | **Checkpoints** | **LE** | **FR** | **EMS** |
| 71 | Police will drive vehicle of intoxicated driver to a staging location | 3 | | |
| **Item No.** | **Stabilization and Extrication** | **LE** | **FR** | **EMS** |
| 72 | Occupant may be asked to power down vehicle if more familiar and able | | 1 | |
| 73 | Larger operations or operations involving larger vehicles have increased durations | | 2 | |

# Appendix E: Jurisdictional Breakdown of ADS-related Participant Feedback

**Table 49. Jurisdictional Breakdown for ADS-related Feedback (Part 1)**

| Participant Feedback | Jurisdictional Breakdown | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | SLE | RCLE | PCLE | RTLE | UCLE | CLE | PFR | VFR | PEM | VEM | SUM |
| **Respond to Incident** | | | | | | | | | | | |
| Identify and respond to emergency vehicles | 5 | 5 | | 3 | | 1 | | | 1 | | 15 |
| Sense manual traffic signal changes | | | | | | | | | 1 | | 1 |
| Communicate with public safety officials | 1 | | | | | | | | | | 1 |
| Consistently respond to emergency vehicles | 10 | 3 | | 3 | 2 | 7 | | 1 | 2 | 2 | 30 |
| Identify vehicle in DO | 5 | | | 1 | 1 | 4 | 1 | | 1 | 2 | 15 |
| Identify vehicle at scene (responding to) in DO | 3 | | | | 1 | | | | 1 | 3 | 8 |
| Determine if vehicle at scene (responding to) has occupants | | | | | 1 | | | | 1 | | 2 |
| Feedback emergency vehicle has been recognized | 1 | | | | | | | | | 1 | 2 |
| **Secure a Scene** | | | | | | | | | | | |
| Disable the vehicle | 8 | 1 | 3 | 6 | 12 | | 9 | 6 | | 4 | 49 |
| Move vehicle from roadway | 6 | | | 3 | 1 | | | | | | 10 |
| Access vehicle interior | | | | | | | 1 | | | | 1 |
| Secure a scene for vehicles to navigate | 3 | | | | | | 6 | 2 | | 1 | 12 |
| Signal to vehicle to move or stop | 2 | 2 | | | | | 2 | | | | 6 |
| Communicate advanced warnings to other vehicles | 2 | | 1 | | | | | 2 | | | 5 |
| Sense temporary traffic signs and signals | | | | | | | 1 | | 2 | | 3 |
| Detect public safety officials walking in front of vehicle | | | | | | | | | 1 | | 1 |
| Extract pre-incident data from vehicle | 17 | | 2 | 4 | 4 | | | | | | 27 |
| Attribute responsibility of incident | 7 | 3 | 5 | 6 | 1 | | | | | | 22 |
| Determine how vehicle is powered | 1 | | | 2 | 3 | | 3 | 2 | | 1 | 12 |
| Determine if vehicle contained occupants | 2 | 1 | 1 | 2 | 4 | | | | 1 | | 11 |
| Identify who to contact regarding vehicle | 3 | | 3 | 2 | 1 | | | | | | 9 |
| Identify vehicle in DO | 2 | | 1 | 2 | 2 | | | | | | 7 |

| Participant Feedback | Jurisdictional Breakdown | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | SLE | RCLE | PCLE | RTLE | UCLE | CLE | PFR | VFR | PEM | VEM | SUM |
| Identify vehicle owner | | | 2 | 1 | 1 | | | | 1 | | 5 |
| Detect hazards unique to the vehicle | 1 | | | | 3 | | | | | | 4 |
| Anticipate how vehicles will respond when approached | 1 | | | 2 | 1 | | | | | | 4 |
| Exchange documentation (e.g., license, registration, insurance, and citation) | 1 | | 1 | 1 | | | | | | | 3 |
| Determine vehicle is safe to continue after incident | 2 | | | | | | | | | | 2 |
| Feedback that vehicle correctly interpreted commands or direction | | | | 1 | | | | 1 | | | 2 |
| Provides exact location of incident | | | | | 2 | | | | | | 2 |
| Determine mode the vehicle was in prior to and during incident | | | | | 1 | | | | | | 1 |
| If vehicle data can be remotely accessed or altered | 1 | | | | | | | | | | 1 |
| If nearby ADS-equipped vehicles can be used for medical transport | | | | | | | | | 1 | | 1 |
| **Traffic Direction and Control** | | | | | | | | | | | |
| Signal directions to vehicles | 6 | 10 | 6 | 1 | 7 | 1 | 1 | | 5 | 1 | 38 |
| Communicate with surrounding vehicles | | 2 | | | 2 | 2 | 4 | | 3 | 1 | 14 |
| Sense temporary traffic signs and signals | 3 | 1 | 1 | | 2 | 1 | 1 | | | 1 | 10 |
| Sense public safety officials and distinguish them from pedestrians | 4 | 1 | 1 | | 1 | | | | 1 | 1 | 9 |
| Direct to violate highway rules | 1 | 1 | | | | | 2 | | | | 4 |
| Recognize and respond to slowing traffic | 1 | | | | | | 1 | 1 | | | 3 |
| Anticipate behavior and reaction to traffic control | 5 | 2 | 2 | | 3 | 1 | 1 | | 3 | 2 | 19 |
| Identify an ADS-equipped vehicle in DO | 3 | | 1 | | 3 | | 4 | 1 | 2 | | 14 |
| Receive feedback that vehicle understood commands | | 1 | 1 | | 3 | 1 | | | 1 | 2 | 9 |
| Anticipate behavior in rural areas | | | 2 | | | | | | | | 2 |
| Recognize distance vehicles can sense public safety officials | | | | | | | | | 1 | | 1 |

| | | | | | |
|---|---|---|---|---|---|
| **SLE** | State Law Enforcement | **RTLE** | Rural Town Law Enforcement | | Direct Interaction |
| **RCLE** | Rural County Law Enforcement | **UCLE** | Urban City Law Enforcement | | Indirect Interaction |
| **PCLE** | Populous County Law Enforcement | **CLE** | Canadian Law Enforcement | | Informational Interaction |
| **PFR** | Paid Fire and Rescue | PEM | Paid EMS | | |
| **VFR** | Volunteer Fire and Rescue | VEM | Volunteer EMS | | |

**Table 50: Jurisdictional Breakdown for ADS-related Feedback (Part 2)**

| Participant Feedback | Jurisdictional Breakdown | | | | | | | | | | SUM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **SLE** | **RCLE** | **PCLE** | **RTLE** | **UCLE** | **CLE** | **PFR** | **VFR** | PEM | VEM | |
| **Traffic Stops and Checkpoints** | | | | | | | | | | | |
| Signal vehicle to pull over and stop | 5 | | 6 | | 3 | 2 | | | | | 16 |
| Stop or direct vehicle to safer location | 4 | | 1 | | | 1 | | | | | 6 |
| Recognize traffic stop from emergency response | | | 3 | | | | | | | | 3 |
| Remotely control vehicle to stop or slow | | | | | | 1 | | | | | 1 |
| Determine who is responsible | 9 | | 2 | 4 | 6 | | | | | | 21 |
| Write the citation or warning | 6 | 1 | 3 | 1 | 2 | | | | | | 13 |
| Recognize if operating or is capable of operating in DO | 1 | 1 | 3 | | 2 | 4 | | | | | 11 |
| Identify who to communicate with during stop | 5 | | 1 | | 3 | | | | | | 9 |
| Determine if vehicle is experiencing a malfunction | 3 | 1 | | 1 | 2 | 2 | | | | | 9 |
| Retrieve vehicle data | 1 | | 2 | | 1 | | | | | | 4 |
| Receive feedback that vehicle will stop in a safe location | 1 | 1 | | | | 1 | | | | | 3 |
| Access vehicle registration and insurance information | | 1 | | 1 | | | | | | | 2 |
| Anticipate how quickly vehicle will react to traffic stop initiation | 1 | | 1 | | | | | | | | 2 |
| Receive feedback vehicle intends to stop | 1 | | | | | | | | | | 1 |
| Identify who may be controlling the vehicles | 1 | | | | | | | | | | 1 |
| **Abandoned or Unattended Vehicles** | | | | | | | | | | | |
| Disable vehicle | 3 | 1 | | | 1 | | | | | | 5 |
| Anticipate vehicle's reactions when approached | 2 | | 1 | 1 | | | | | | | 4 |

| Participant Feedback | Jurisdictional Breakdown | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **SLE** | **RCLE** | **PCLE** | **RTLE** | **UCLE** | **CLE** | **PFR** | **VFR** | PEM | VEM | SUM |
| Signal vehicle (using another vehicle) | | 1 | | 1 | | | | | | | 2 |
| Communicate with vehicle | | 1 | | | | | | | | | 1 |
| Contact owner or controller of vehicle | 3 | | 2 | 5 | 1 | | | | | | 11 |
| Determine the intentions of the vehicle (abandoned, malfunctioning, or staging) | 6 | 1 | 1 | 1 | | | | | | | 9 |
| Recognize if a vehicle is operating in DO | 3 | | 2 | 2 | 1 | | | | | | 8 |
| Identify potential malfunctions | 1 | 1 | 1 | 2 | | | | | | | 5 |
| Anticipate how vehicles will react/behave | 2 | | 1 | 1 | | | | | | | 4 |
| Use VIN to identify owner | | | | 1 | | | | | | | 1 |
| **Stabilization and Extrication** | | | | | | | | | | | |
| Disable vehicle (park and paralyze) | | | | | | | 5 | | | | 5 |
| Cut power to the vehicle | | | | | | | 4 | | | | 4 |
| Start the vehicle if components need operated | | | | | | | 1 | | | | 1 |
| Access vehicle interior | | | | | | | 1 | | | | 1 |
| Determine if vehicle contained occupants prior to arrival | | | | | | | 2 | | | | 2 |
| Determine appropriate equipment for stabilization | | | | | | | 1 | | | | 1 |
| Identify potential unique hazards associated with vehicle | | | | | | | 1 | | | | 1 |

| | | | | | |
|---|---|---|---|---|---|
| **SLE** | State Law Enforcement | **RTLE** | Rural Town Law Enforcement | | Direct Interaction |
| **RCLE** | Rural County Law Enforcement | **UCLE** | Urban City Law Enforcement | | Indirect Interaction |
| **PCLE** | Populous County Law Enforcement | **CLE** | Canadian Law Enforcement | | Informational Interaction |
| **PFR** | Paid Fire and Rescue | PEM | Paid EMS | | |
| **VFR** | Volunteer Fire and Rescue | VEM | Volunteer EMS | | |

# References

Ahrens, M., & Evarts, B. (2017). Fire Department Roadway and Vehicle Incidents. In: NFPA.

American Automobile Association. (2018). Move Over Law. *Digest of Motor Laws.* Retrieved from http://drivinglaws.aaa.com/tag/move-over-law/

American Red Cross. (2018). What is BLS? Retrieved from https://www.redcross.org/take-a-class/performing-bls/what-is-bls

Annett, J. (2003). Hierarchical Task Analysis. In E. Hollnagel (Ed.), *Handbook of Cognitive Task Design* (pp. 17-35). Mahwah, New Jersey: Lawrence Erlbaum Associates.

*The BigEasy*. (2015). Retrieved from https://www.steckmfg.com/graphics/BigEasy_Instructions.pdf

California Department of Motor Vehicles. (2018a). Application Requirements for Autonomous Vehicle Tester Program - Testing with a Driver. Retrieved from https://www.dmv.ca.gov/portal/dmv/detail/vehindustry/ol/auton_veh_tester

California Department of Motor Vehicles. (2018b). Permit Holders (Testing with a Driver). Retrieved from https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/permit

California POST. (2007). *California Law Enforcement Vehicle Pursuit Guidelines 2006*. California: California Commission on Peace Officer Standards and Training Retrieved from http://lib.post.ca.gov/Publications/vp_guidelines.pdf

Carrick, G., & Washburn, S. (2012). The move over law: Effect of emergency vehicle lighting on driver compliance on Florida roadways. *Transportation Research Record: Journal of the Transportation Research Board, 2281*, 1-7. doi:10.3141/2281-01

Census 2000 Urban and Rural Classification. (2015). *Geography.* Retrieved from https://www.census.gov/geo/reference/ua/urban-rural-2000.html

Centers for Disease Control and Prevention. (2015). Sobriety Checkpoints. *Motor Vehicle Safety.* Retrieved from https://www.cdc.gov/motorvehiclesafety/calculator/factsheet/checkpoints.html

Cincinnati Police. (2014). *Traffic Enforcement*. Retrieved from https://www.cincinnati-oh.gov/police/assets/File/Procedures/12205.pdf

City of Hilliard. (2018). Vehicle lockout. Retrieved from http://hilliardohio.gov/police/general-services/vehicle-lockout

City of Madison Police Department. (2016). *Vehicle Escorts*. Retrieved from Madison, WI:

Davis, K. (2016). Preparing for a Future with Autonomous Vehicles. *The Police Chief, 83*.

EMS.gov. What is EMS? Retrieved from https://www.ems.gov/whatisems.html

FC Emergency Medical Services. (2018). Advanced Life Support (ALS). Retrieved from http://www.fcems.org/advanced-life-support.html

FDNY. (2016). *FDNY Probationary Firefighters Manual*. F.D.N.Y Retrieved from https://www1.nyc.gov/assets/fdny/downloads/pdf/join/join-Probie-Manual.pdf

Federal Emergency Management Agency. (2013). *Introduction to the Incident Command System*.

Federal Highway Administration. (2010). *Traffic Incident Management Handbook Update* (FHWA-HOP-10-013). Retrieved from Washington, DC

Federal Interagency Committee on Emergency Medical Services. (2011). *National EMS Assessment* (DOT HS 811 723). Retrieved from https://www.ems.gov/pdf/811723-National-EMS-Assessment-2011.pdf

Fell, J., Compton, C., & Voas, R. (2008). A Note on the Use of Passive Alcohol Sensors during Routine Traffic Stops. *Traffic injury prevention, 9*(6), 534-538. doi:http://doi.org/10.1080/15389580802282566

Flint Hill Fire Department. (2013). *Standard Operating Guideline: Lock-in/Lock-out*. Retrieved from Flint Hill, NC: http://flinthillfire.org/wordpress/?page_id=413

Florida Highway Patrol. (2015). *Florida Highway Patrol Policy Manual*. Tallahassee: Florida Highway Patrol.

Gaines, L., & Kappeler, V. (2010). *Policing in America 7th Edition*: Elsever.

General Motors. (2018). *2018 Self-driving safety report*. Retrieved from http://www.gm.com/content/dam/gm/en_us/english/selfdriving/gmsafetyreport.pdf

Greenbelt Police Department. (2007). *Traffic Direction and Control*. Greenbelt, Maryland.

Gunderson, M. (2015). *Principles of EMS System Design*. In M. T. R. D. M. David C. Cone MD; Jane H. Brice MD, MPH; J. Brent Myers MD, MPH (Ed.). Retrieved from https://onlinelibrary.wiley.com/doi/pdf/10.1002/9781118990810.ch75

Hallinan, B. (2015). The EMT's and Paramedic's Role in Vehicle Extrication. *Journal of Emergency Medical Services*.

health.ny.gov. (2000). The Operation Of Emergency Medical Services Vehicles. *Policy Statement 00-13*. Retrieved from https://www.health.ny.gov/professionals/ems/policy/00-13.htm

Hendrick, H., & Kleiner, B. (2001). Macroergonomics: An introduction to work system design. *Human Factors and Ergonomics Society*.

Honda North America. (2018a). *Clarity Plug-In Hybrid 2018 Honda Clarity Plug-In Hybrid Emergency Response Guide*. Retrieved from

Honda North America. (2018b). *MDX Sport Hybrid 2017-18 Acura MDX Sport Hybrid Emergency Response Guide*. Retrieved from https://techinfo.honda.com/rjanisis/pubs/web/RJAAI001_HYBRID.htm

Houston Police Department. (2004). Traffic Control. In *Traffic Control* (Vol. Article XVIII). Houston, Texas: Office of the Chief of Police.

International Association of Chiefs of Police. (2004). *Manual of Police Traffic Services Policies and Procedures*. Retrieved from Alexandria, VA: https://www.iadlest.org/Portals/0/Files/Documents/DDACTS/Docs/Manual%20of%20Police%20Traffic%20Services%20Policies%20and%20Procedures,%20IACP,%20July%202004.pdf

International Fire Service Training Association. (2013). *Essentials of Fire Fighting* (6th ed.): Fire Protection Publications.

International Organization for Standardization. (1985). Documentation symbols and conventions for data, program and system flowcharts, program network charts and system resource charts. In *Information Processing* (Vol. 5807:1985).

Jackson, M. D. (2013). *Police Officer Field Training Manual*. Retrieved from https://www.ci.medford.or.us/files/Police%20Field%20Training%20Manual%206-14-2013.pdf

LaFave, W. R. (2004). The "Routine Traffic Stop" from Start to Finish: Too Much "Routine," Not Enough Fourth Amendment. *Michigan Law Review, 102*(8), 1843-1905.

Lakewood.org. (2018). Vehicle Stop Procedures. *9124*. Retrieved from http://www.lakewood.org/Documents/Police/Policy_and_Procedure_Manual/PP-9124_VEHICLE_STOP_PROCEDURES.ASPX

Lamboy, J. (2012, March 16, 2012). Traffic Stop Dos and Don'ts. Retrieved from https://www.dmv.org/articles/traffic-stop-dos-and-donts/

Marshall, C., & Rossman, G. B. (1999). *Designing qualitative research* (3rd Ed.). Thousand Oaks, CA: Sage Publications.

Maryland Motor Vehicle Administration. (2016). *Maryland Driver's Manual*. Retrieved from Glen Burnie, MD.

Miller, G., Galanter, E., & Pribram, K. (1960). *Plans and the structure of behavior*. New York: Holt.

Miller, R. B. (1962). Task description and analysis. In R. M. Gagné (Ed.), *Psychological Principles in System Design* (pp. 187-228). New York: Holt, Rinehart and Winston.

Missouri Department of Revenue. (2011). *Abandoned Property Manual*. Retrieved from Jefferson City, MO.

Moore, J. E., Giuliano, G., & Cho, S. (2004). Secondary Accident Rates on Los Angeles Freeways. *Journal of Transportation Engineering, 130*(3), 280-285. doi:doi:10.1061/(ASCE)0733-947X(2004)130:3(280)

Mothers Against Drunk Driving. (2012). *Sobriety Checkpoints*. Retrieved from Washington, DC

Murgado, A. (2012). How to Approach Traffic Stops. *Police, 36*, 16-18.

*MUTCD*. (2009). FHWA Retrieved from mutcd.fhwa.dot.gov/.

National Fire Protection Association. (2015). Electric Vehicle Field Guide. In: National Fire Protection Association.

National Fire Protection Association. (2017). *Standard for Technical Rescue Personnel Professional Qualifications*. Retrieved from https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1006

National Fire Protection Association. (2018). Emergency response guides.

National Highway Traffic Safety Administration. (1999). *Sobriety Checkpoints and Saturation Patrols*. Retrieved from Washington, DC: https://one.nhtsa.gov/people/injury/alcohol/saturation_patrols/HowToGuide.html

National Highway Traffic Safety Administration. (2002). *Saturation Patrols & Sobriety Checkpoints Guide* (DOT HS 809 063). Retrieved from

National Highway Traffic Safety Administration. (2009). *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices*. Retrieved from Washington, DC.

National Highway Traffic Safety Administration. (2017). *MMUCC Guideline: Model Minimum Uniform Crash Criteria*. Retrieved from Washington, DC: https://crashstats.nhtsa.dot.gov/Api/Public/Publication/812433

National Highway Traffic Safety Administration. (2018). Automated Driving Systems 3.0 Preparing for the Future of Transportation. Retrieved from https://www.transportation.gov/sites/dot.gov/files/docs/policy-initiatives/automated-vehicles/320711/preparing-future-transportation-automated-vehicle-30.pdf

North Carolina Division of Motor Vehicles. (2016). *North Carolina Driver's Handbook*. Retrieved from Raleigh, NC: https://www.ncdot.gov/download/dmv/handbooks_ncdl_english.pdf

Northampton Police Department. (1999). Police Assistance to Motorists & Roadway Safety. In *Administration and Operations Manual*. Northampton, Massachusetts: Northampton Police Department.

Nugent, H., Connors, E. F., McEwen, J. T., & Mayo, L. (1990). *Restrictive Policies for High-Speed Police Pursuits*. Retrieved from Washington, DC.

Office of Justice Programs. (2017). Traffic Stops. Retrieved from https://www.bjs.gov/index.cfm?tid=702&ty=tp

Pratt, F., Pepe, P., Katz, S., & Persse, D. (2007). PreHospital 911 Emergency Medical Response: The Role of the US Fire Service in Delivery and Coordination," International Association of Fire Fighters. *International Association of Fire Fighters*.

Ritchie, J., Spencer, L., & O'Conner, W. (2003). *Carrying out qualitative analysis: A guide for social science students and researchers.* In J. Ritchie & J. Lewis (Eds.), Qualitative research practice (pp. 219-262). London: Sage.

Roberts, D. J., & Casanova, M. (2012). *Automated License Plate Recognition (ALPR) Use by Law Enforcement: Policy and Operational Guide, Summary*. Retrieved from Alexandria, VA.

Rockville City Police Department. (2010). *General Order: Residential and Vehicle Lockouts*.

Rogers Fire Department. (2017). *Roadway Incident Saftey*. Retrieved from Rogers, AR: http://rogersar.gov/DocumentCenter/View/1202/SOP-304---Roadway-Incident-Safety

SAE International. (2012). *Hybrid and EV First and Second Responder Recommended Practice J2990_201211*. Retrieved from Warrendale, PA: https://www.sae.org/standards/content/j2990_201211/

SAE International. (2018). J3016_201806: Surface Vehicle Recommended Practice. In *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles*.

San Antonio Police Department. (2015). *Procedure 506: Traffic Law Enforcement: General Manual*. Retrieved from http://www.sanantonio.gov/Portals/0/Files/SAPD/GeneralManual/506%20Traffic%20Law%20Enforcement%20(03-11-15).pdf

San Jose Police. (2018). *San Jose Police Department Policies, Rules, Procedures*. Retrieved from file:///C:/Users/tterry/Downloads/Duty_Manual_REDACTED_2018_v1.pdf.

Seattle.gov. (2003). *Traffic Direction and Control* (Vol. 16.140). Seattle, Washington: Seattle.gov.

Shelby County Emergency Medical Services. (2012). *Standard Operating Guidelines*. Retrieved from

https://shelbycounty.ky.gov/Departments/Documents/EMS%20Standard%20Op%20Guide%203%2020%202012.pdf

Shepherd, A. (1985). Hierarchical Task Analysis and Training Decisions. *PLET: Programmed Learning & Educational Technology, 22*(2), 162-176. doi:10.1080/1355800850220209

Stanton, N. A. (2006). Hierarchical task analysis: Developments, applications, and extensions. *Applied Ergonomics*, *37*, 55-79.

State of New Jersey. (2012). *New Jersey State Police Standing Operating Procedure: Escorts*. West Trenton, NJ: State of New Jersey Office of the Attorney General.

Stradling, R. (2018). Do you know what to do when a police officer pulls you over? NC has new guidelines. *The News Observer*. Retrieved from http://www.newsobserver.com/news/traffic/article193751114.html

Sweet, D. (2012). *Vehicle Extrication: Levels I & II: Principles and Practice*. Boston: Jones & Bartlett Learning.

Texas Education Agency (Producer). (2011, May 26, 2018). Basic Traffic Stops: Law Enforcement I. *Law, Public Safety, Corrections & Security*. [PowerPoint]

U.S. Fire Administration. (2018). U.S. Fire Administration, Working for a Fire-Safe America. Retrieved from https://www.usfa.fema.gov/

UCLA Center for Prehospital Care. (2018). What's the Difference between an EMT and a Paramedic. Retrieved from https://www.cpc.mednet.ucla.edu/node/27

Utah Department of Public Safety. (2018). FAQ - Disabled Vehicles. *Highway Patrol.*

Virginia Department of Motor Vehicles. (2017). *Virginia Driver's Manual*. Retrieved from Richmond, VA.

Virginia State Police. (2010). Motorist Assistance Program. Retrieved from http://www.vsp.state.va.us/BFO_MotoristAssistance.shtm

Virginia.gov. (2011). *Abandoned, Immobilized, Unattended and Trespassing Vehicles; Parking*. Retrieved from https://law.lis.virginia.gov/vacode/46.2-1200

Waymo. (2018a). *Driverless Autonomous Vehicle Tester Program*. Mountain View, CA Retrieved from http://www.documentcloud.org/documents/4458000-Waymo-Driverless-AV-Application.html

Waymo. (2018b). Emergency Response Supplement. *Fully Self-Driving MY 2017 Pacifica.* 1.0. Retrieved from https://www.documentcloud.org/documents/4457998-Waymo-Emergency-Response-Supplement.html

Wickert, G. (2017). *Funeral Procession Traffic Laws in All 50 States*. Retrieved from Hartford, WI.

Wisconsin Department of Transportation. (2014). *Emergency Traffic Control and Scene Management Guidelines*. Madison, WI.