

**GOAL ONE: A SAFE RETURN EACH  
AND EVERY DAY**

**Safety Guidelines for  
Transportation  
Researchers**

**Manual**

**SPR 304-731**



Oregon Department of Transportation



**GOAL ONE: A SAFE RETURN EACH AND EVERY DAY**

**Safety Guidelines for Transportation Researchers Manual**

**SPR 304-731**

by

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<p>Abstract</p> <p>Universities, colleges, and other learning institutions regularly conduct research on behalf of state departments of transportation (DOTs). Much of the research involves data collection and testing work by student researchers on roadways and other types of field sites. The field research may require students to work on the roadway, in the right-of-way, or close to live traffic environments. As a result, the working conditions expose the students to safety hazards created by the exposure to passing traffic, surrounding work equipment, work operations, and site conditions. Safety precautions are needed to protect the students from the associated increased risk of injury. In many cases, the students performing the work have little prior experience working on active roadways, and often minimal if any safety training. Formal safety training and the availability of training resources are needed to provide these students with adequate knowledge and skills to ensure that they know how to work safely on roadways when conducting research-related activities. This document aims to provide a resource for safety training to student research assistants and any other personnel who conduct research on roadways near or in traffic. The manual is designed to accompany the video titled "Goal One: A Safe Return Each and Every Day." After reading the manual and watching the video, student researchers will: (1) Understand the likely hazards present in roadway work areas; (2) Know how to prepare for working on roadway work sites; and (3) Know how to conduct their work on roadways safely. DOTs and universities are encouraged to use the manual for training students regarding how to work safely on roadways when performing research.</p>					
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## SI\* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS					APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	When You Know	Multiply By	To Find	Symbol	Symbol	When You Know	Multiply By	To Find	Symbol
<b><u>LENGTH</u></b>					<b><u>LENGTH</u></b>				
in	inches	25.4	millimeters	mm	mm	millimeters	0.039	inches	in
ft	feet	0.305	meters	m	m	meters	3.28	feet	ft
yd	yards	0.914	meters	m	m	meters	1.09	yards	yd
mi	miles	1.61	kilometers	km	km	kilometers	0.621	miles	mi
<b><u>AREA</u></b>					<b><u>AREA</u></b>				
in <sup>2</sup>	square inches	645.2	millimeters squared	mm <sup>2</sup>	mm <sup>2</sup>	millimeters squared	0.0016	square inches	in <sup>2</sup>
ft <sup>2</sup>	square feet	0.093	meters squared	m <sup>2</sup>	m <sup>2</sup>	meters squared	10.764	square feet	ft <sup>2</sup>
yd <sup>2</sup>	square yards	0.836	meters squared	m <sup>2</sup>	m <sup>2</sup>	meters squared	1.196	square yards	yd <sup>2</sup>
ac	acres	0.405	hectares	ha	ha	hectares	2.47	acres	ac
mi <sup>2</sup>	square miles	2.59	kilometers squared	km <sup>2</sup>	km <sup>2</sup>	kilometers squared	0.386	square miles	mi <sup>2</sup>
<b><u>VOLUME</u></b>					<b><u>VOLUME</u></b>				
fl oz	fluid ounces	29.57	milliliters	ml	ml	milliliters	0.034	fluid ounces	fl oz
gal	gallons	3.785	liters	L	L	liters	0.264	gallons	gal
ft <sup>3</sup>	cubic feet	0.028	meters cubed	m <sup>3</sup>	m <sup>3</sup>	meters cubed	35.315	cubic feet	ft <sup>3</sup>
yd <sup>3</sup>	cubic yards	0.765	meters cubed	m <sup>3</sup>	m <sup>3</sup>	meters cubed	1.308	cubic yards	yd <sup>3</sup>
NOTE: Volumes greater than 1000 L shall be shown in m <sup>3</sup> .									
<b><u>MASS</u></b>					<b><u>MASS</u></b>				
oz	ounces	28.35	grams	g	g	grams	0.035	ounces	oz
lb	pounds	0.454	kilograms	kg	kg	kilograms	2.205	pounds	lb
T	short tons (2000 lb)	0.907	megagrams	Mg	Mg	megagrams	1.102	short tons (2000 lb)	T
<b><u>TEMPERATURE (exact)</u></b>					<b><u>TEMPERATURE (exact)</u></b>				
°F	Fahrenheit	(F-32)/1.8	Celsius	°C	°C	Celsius	1.8C+32	Fahrenheit	°F

\*SI is the symbol for the International System of Measurement





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## 1.0 INTRODUCTION

Many state departments of transportations (DOTs) contract with universities, colleges, and other learning institutions to conduct research that involves data collection and testing work on roadways and other types of field sites. The field of transportation research is one such area. Conducting and managing data collection and implementing various testing devices in the field may require researchers to work on the roadway, in the right-of-way, or close to live traffic environments. As a result, the working conditions expose researchers to safety hazards created by the exposure to passing traffic, surrounding work equipment, work operations, and site conditions. Safety precautions are needed to protect the researchers – often undergraduate and graduate students – from the associated increased risk of injury.

Performing the research work commonly involves student research assistants who are hired to participate in the research during or as part of their education. In many cases, the students performing the work have little prior experience working on active roadways, and often minimal if any safety training. Formal safety training and the availability of training resources are needed to provide these students, and all future students who enter the transportation industry, with adequate knowledge and skills to ensure that they know how to work safely on roadways when conducting research-related activities.

The aim of this manual is to provide a resource for safety training to student research assistants and any other personnel who conduct research near or in traffic. The manual is designed to accompany the video titled “Goal One: A Safe Return Each and Every Day” that illustrates the safety training concepts and requirements presented in the manual. The video is available under the Oregon DOT YouTube Channel, at the following Internet address: [https://youtu.be/iz\\_fde-xtxc](https://youtu.be/iz_fde-xtxc).

It is recommended that this manual be read in conjunction with watching the video. After reading the manual and watching the video, student researchers will:

- Understand the likely hazards present in roadway work areas;
- Know how to prepare for working on roadway work sites; and
- Know how to conduct their work on roadways safely.





## 2.0 INJURIES AND FATALITIES ON ROADWAYS

In 2015, there were 642 fatalities from crashes in work zones. This equates to approximately 2% of all roadway fatalities nationally (FHWA 2017), and 1.76 work zone fatalities per day. The annual number of work zone fatalities varies. Fatality Analysis Reporting System (FARS) data indicate that 590 work zone fatalities occurred in 2011, 617 in 2012, 579 in 2013, 669 in 2014, and 642 in 2015. Work zone crashes occur at a higher rate than non-work zone crashes. FHWA reports that “if fatalities occurred in work zone crashes at the same rate as non-work zone crashes, that would mean a total of 164 lives saved in 2015 (FHWA 2017).

Both motorists and workers are involved in injury and fatality incidents on roadways. The Federal Highway Administration (FHWA) maintains data on the circumstances related to injuries and fatalities that occur on roadways. In terms of fatalities, FHWA highlights the following three primary causes of fatalities in roadway work areas (FHWA 2017):

- *Runovers/backovers*: Workers in roadway work areas being run over or backed over by vehicles, either construction/maintenance equipment or public automobiles.
- *Vehicle collisions*: Fatalities as a result of collisions between operating construction/maintenance equipment and/or non-construction/maintenance equipment.
- *Caught in/between or struck by object*: Workers caught in/between equipment, or struck by equipment or other objects.

In addition to fatalities, many workers are injured in work sites. The most common causes of the injuries by percentage are as follows (Lincoln and Fosbroke 2010):

- Contact with objects or equipment (35%)
- Slips, trips, or falls (20%)
- Overexertion (15%)
- Transportation incidents (12%)
- Exposure to harmful substances or environments (5%)

The percentages shown above indicate that the majority of injuries to workers in roadway work areas come from performing the work, the site conditions, and worker behavior. Those in roadway work areas are at risk of injury due to incidents with public vehicles, yet this cause of injury is not as great as other causes. In addition, a high percentage of the incidents involve workers on foot who are injured. Workers who are not protected by a vehicle or piece of equipment are more susceptible to injury and fatality than those who are in a vehicle or large piece of equipment.

Why do workers on roadway work sites get injured? A review of National Highway Transportation Safety Administration (NHTSA) data from 2011-2013 shows that in roadway work areas, the actions most commonly being undertaken by non-motorists at the time of any injury or fatality were: failure to yield right-of-way, in roadway improperly (standing, lying, working, playing, etc.), improper crossing of roadway or intersection (jaywalking), and wearing non-visible attire (e.g., dark clothing, no personal light) (NHTSA 2016, as reported in Gambatese et al 2017). Specific to work behaviors and human factors, other reasons typically found to lead to injuries include being distracted and feeling pressure/stress. Human behavior causes of incidents include the following:

- *Mistake/error*: An unintentional miscalculation, blunder, or oversight in action or decision-making.
- *Absent-minded/forgetful*: Unintentional pre-occupied wandering of the mind from the present such that one is unaware of one's immediate surroundings. Lost in thought such that one does not realize current actions, surrounding conditions, and immediate hazards.
- *Uncaring/indifferent*: Showing little or no care or concern for personal protection or the safety of others, or giving other goals and values (e.g., profit, status, and personal opinion and feelings) higher priority than personal protection or the safety of others.
- *Ignorance*: Lack of knowledge, experience, or information about the conditions and actions at hand.
- *Poor risk management*: Insufficient or careless assessment of the safety risk associated with identified hazards, and faulty or inferior decision-making and control of the calculated risk.
- *High risk tolerance*: A high permissible level of risk based on which the need for safety controls is determined.

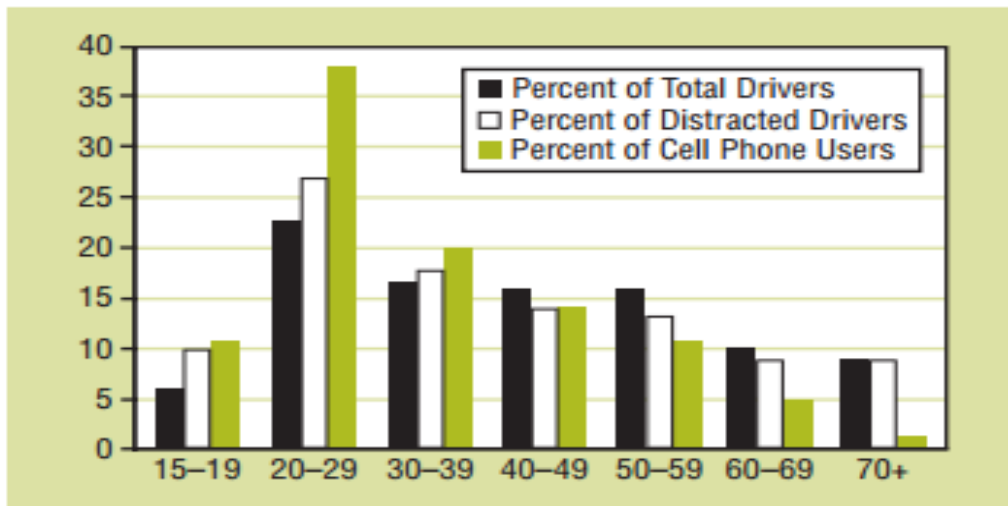
### 3.0 SAFETY HAZARDS IN TRANSPORTATION RESEARCH ENVIRONMENTS

Transportation field research work sites contain many different types of hazards that affect the safety of those who work on the sites. Close proximity to high speed traffic and construction equipment, working at elevation, and working in noisy, crowded areas are some of the many examples of safety hazards present on many field research sites. Provided below is a description of typical safety hazards present in transportation research work areas. The hazards are organized into three categories: (1) Passing Vehicles, (2) Site Hazard, and (3) Worker Behavior. All categories are impactful on safety and should be considered when planning research activities on roadway work sites. The list of hazards is not comprehensive; other types of hazards may be present that researchers should look out for.

#### 3.1 PASSING VEHICLES: DISTRACTED/IMPAIRED DRIVING

Working adjacent live traffic exposes workers to being hit by errant vehicles or mistakenly walking into the path of the passing traffic. Drivers may be distracted and not pay attention to their path of travel, speed, location, or roadway conditions. Estimates of distracted driving suggest that distraction contributes to 16% of all fatal crashes, resulting in approximately 5,000 deaths every year (AAA Foundation 2017). Figure 3.1 shows a distribution of drivers involved in fatal crashes in 2013 (NHTSA 2015). This risky behavior poses a danger to vehicle occupants as well as non-occupants such as workers on the roadway, pedestrians, and bicyclists. Oftentimes, discussions regarding distracted driving center around cell phone use and texting, but distracted driving also includes other activities such as eating, talking to other passengers, or adjusting the radio or climate controls (NHTSA 2015).

**Percent Distribution of Drivers Involved in Fatal Crashes By Age, Distraction, and Cell Phone Use, 2013**



Source: NCSA, FARS 2013 (ARF)

**Figure 3.1: Driver Distraction in Fatal Crashes (NHTSA 2015)**

In addition, drivers may be impaired as a result of being fatigued, under the influence of alcohol or drugs, or due to physical conditions or age. Fatigue and impaired due to alcohol/drug use is commonly higher during nighttime hours. Drivers under such conditions may not be aware of roadway conditions, signage, and other vehicles, leading to errant vehicles in roadway work areas.

### 3.2 PASSING VEHICLES: HIGH SPEED

High vehicle speed also poses a hazard to motorists and workers on roadways. Higher vehicle speeds allow drivers less time to react to roadway conditions and slow down. A one second advantage means a lot when the vehicle is travelling at a high rate of speed. Table 3.1 shows the distances it takes an average car to come to a stop on dry pavement when travelling at different speeds (Government Fleet 2017).

**Table 3.1: Vehicle Stopping Distance (Government Fleet 2017)**

Speed (mph)	Perception/Reaction Distance (feet)	Braking Distance (feet)	Overall Stopping Distance (feet)	Approximate Number of Car Lengths (15 feet/car length)
30	44	45	89	6
40	59	80	139	9
50	73	125	198	14
60	88	180	268	18
70	103	245	348	23
80	117	320	439	29

### 3.3 PASSING VEHICLES: VISIBILITY

Visibility while driving is a key component of safe driving. Drivers need to have visibility of the travel path, adjacent/crossing vehicles, pedestrians/workers on the roadway, and roadway infrastructure. Inhibited driver visibility creates a hazardous condition for those working on the roadway. Some factors that affect driver visibility are: nighttime driving, inclement weather, limited sight distance (line of sight obstructed by roadway infrastructure, other vehicles, work equipment, etc.), and glare. A lack of reflective apparel worn by workers on roadways can increase the chance of workers not being seen by motorists.

### 3.4 SITE HAZARD: NATURE OF ROADWAY CHARACTERISTICS

There are differences in safety exposures between different roadway types. Roadways in urban locations contain hazards that are different than those found on roadways in rural locations. Similarly, low-speed roadways present different hazards than high-speed roadways. Other roadway characteristics, such as low or high traffic volume, straight or curved roadway alignment, and single- or multi-lane, may pose unique hazards as well. Be sure to understand the type of roadway on which you are working along with the potential hazards that may be present based on the roadway characteristics. *Do not be complacent and assume that all roadways are*

*alike in terms of safety hazards and the potential for crashes and injuries.* Prior to visiting the site, make a plan that accounts for the expected roadway hazards, and then follow the plan when on the site.

### **3.5 SITE HAZARD: EQUIPMENT BLIND SPOTS**

Large, mobile equipment such as paving machines, rollers, trucks, and excavators have blind spots for the equipment operators. A blind spot is the space around a piece of equipment that is not visible to the operator. Standing in the blind spot places a worker at risk of being struck by the equipment. A basic rule of thumb when working around equipment is that if you cannot see the operator, the operator also cannot see you and therefore you are at risk of getting struck by the equipment.

### **3.6 SITE HAZARD: LOUD AND NOISY ENVIRONMENT**

Large, mobile equipment often creates a high noise level in the area surrounding the equipment. The noise level may be such that damage to hearing can occur. In addition, due to the high level noise level, when standing near the equipment you may not become aware of other hazards in the immediate vicinity and continue proceeding with the work despite the hazards present. Make sure that you wear hearing protection when working in noisy areas. Also, wear brightly colored safety apparel to increase your visibility to others. Use a walkie-talkie or similar device to talk with the equipment operators and work crews, if needed.

### **3.7 SITE HAZARD: WALKING SURFACES**

Roadside work areas can be located in many different locations that have different site conditions. Walking surfaces may be sloped, inconsistent, and slippery, and include holes, steps, and other ground surface features. All of these conditions create hazards for workers walking on the roadway and present the risk of tripping or slipping. The safety risk increases when a worker is not paying attention to the walking surface while walking.

### **3.8 SITE HAZARD: UNLCEAR SIGNAGE**

Temporary signage is often placed in work areas to direct and control the passage of motorists and pedestrians in the work area. Unclear or incorrect warning signs on site create uncertainty for the workers, equipment operators, and motorists. Incorrect sign instructions can put workers at risk of entering an unsafe area or becoming exposed to a safety hazard. Special attention should be given to understanding the intent of the instructions given on the signage, as well as abiding by the sign instructions.

### **3.9 SITE HAZARD: EXPOSURE TO MOVING EQUIPMENT, TOXIC MATERIALS, AND OTHER HAZARDOUS SITE CONDITIONS**

Working on roadway field research sites can expose researchers to many surrounding site and environmental hazards that are not present in non-roadway settings. Crowded work areas can be especially hazardous. Close proximity to large, moving equipment creates a significant hazard for workers on foot. Toxic materials may also be present in work areas that can cause health

hazards for those exposed to the materials. Other environmental conditions such as freezing or extremely hot weather, high winds, heavy dust, high noise levels, and bright sunshine can pose hazards to workers. Those exposed to such conditions should ensure that they are a safe distance away from the hazard, and use appropriate personal protective equipment (e.g., gloves, long-sleeve shirts, sunglasses, etc.) and/or other protective measures.

### **3.10 SITE HAZARD: WORKING AT ELEVATION**

Working at high elevations adjacent free edges is a hazard on many work sites. Falls from elevation is commonly the most common cause of fatality in all construction sectors. On roadway work sites, working on bridges, adjacent deep excavations, on temporary structures (e.g., formwork and scaffolding), and on large equipment places workers at elevations that could potentially lead to injuries if a fall or a collapse of the structure were to occur. Those conducting research may need to work at high elevations to collect test data or monitor passing traffic or work operations. In these situations, the researchers need protection from falling, which can be provided by various engineered controls such as guardrails, personal lanyards, and safety nets.

### **3.11 WORKER BEHAVIOR: LACK OF KNOWLEDGE OF AND ADHERENCE TO SAFETY PRACTICES, PROCEDURES, AND REGULATIONS**

Working on site requires not only knowledge of the hazards to be expected in the work area, but also the practices, procedures, and regulations that are needed to be safe. Lacking knowledge of the safety practices and procedures can lead to injury due to such issues as incorrect use of safety devices, use of an inappropriate safety device, not following safe work practices, or lack of use of a needed safety device. Safety regulations are in place to ensure that workers adhere to the minimum required standards for working safely. Researchers on roadway work sites should ensure that they are aware of the required safety practices and procedures, and make sure that the safe practices and procedures are followed every time.

Adherence to safety regulations also applies to walking and driving on roadways. Complying with driving laws is essential. Moreover, as a pedestrian on the roadway, workers should comply with the traffic controls in place for pedestrians. Don't assume that since you are wearing reflective apparel when walking on the roadway, or driving a university or DOT vehicle, that you do not have to follow the applicable rules of the road.

### **3.12 WORKER BEHAVIOR: INCORRECT OPERATING PROCEDURES**

Similar to implementing the correct safety practices and procedures, workers need to follow approved procedures and steps for conducting the work. If equipment is operated in an incorrect manner, for example, the improper procedure or sequence could create a safety hazard. This type of hazard is present when operating equipment, performing manual work, driving a vehicle, and when performing other work tasks that require special operations. A lack of knowledge of safe operating procedures may be prevalent for people who are new to a work task or equipment, which is often the case for student researchers. Operations manuals should be included with all pieces of equipment and understood by those operating the equipment. Communication and

training regarding safe operating procedures is needed for all researchers prior to starting the research work on the site.

### **3.13 WORKER BEHAVIOR: LACK OF ATTENTION TO THE TASK**

Roadways can be crowded and complex environments. With the many surrounding activities, noises, vibrations, equipment, and people, it can be easy to get distracted. Being distracted when operating a piece of equipment, walking adjacent an active roadway or on an uneven surface, working at elevation, and during other high hazard tasks can lead to potential mistakes and ultimately injuries. It is also important to understand that distractions can come from the surrounding work area but also be related to issues outside of work that are carried into the work operation (e.g., receiving a cell phone call, thinking about plans for dinner after work, worries about co-worker relationships, and planning activities with family/friends). Focusing on the distraction may lead to injuries associated with conducting the work at hand. While conducting research work on roadway work sites, attention should be given to the work being conducted with continued awareness of the surrounding safety hazards.

### **3.14 WORKER BEHAVIOR: OVEREXERTION, REPETITIVE MOTION, AND FATIGUE**

Safety hazards also exist when workers are not at their best in terms of physical ability. Overexertion, such as lifting too much weight or working too fast, can cause strain and sprain injuries, and also lead to not being able to perform future work safely. When a work operation is repeated many times, the repetition can negatively affect a person's physical condition. Fatigue is also a significant concern in many work environments. Whether the fatigue is related to many hours of continuous work, the effects of shift work, or not getting enough rest between work shifts, the impacts are related to both safety and work productivity. Fatigue is a common complaint among those working abnormal hours, and brings a high potential for risk of injury to the worker and to co-workers working nearby. Researchers should plan and conduct their work such that they do not overexert themselves and allow for rest and recuperation between work shifts.

### **3.15 WORKER BEHAVIOR: LACK OF PERSONAL PROTECTIVE EQUIPMENT (PPE)**

Personal safety equipment and apparel (e.g., reflective clothing, hard hat, protective eyewear, gloves, etc.) protect workers from injuries when exposed to a hazard and involved in an accident. Without reflective apparel, for example, drivers and equipment operators may not be able to see workers on site during nighttime work. Similarly, wearing protective eyewear prevents damage to a worker's eyes when exposed to falling debris. While reflective apparel and other types of PPE may be obstructing, uncomfortable, or poorly fitting, wearing PPE is critical to being visible at night and to prevent minor injuries. Choosing not to wear PPE or not having PPE available creates additional safety hazards for researchers on roadway work sites.

### **3.16 WORKER BEHAVIOR: POOR RISK ASSESSMENT AND HIGH RISK TOLERANCE**

Analyzing a hazardous situation and determining how to proceed requires a number of steps. First the unsafe situation or condition must be recognized as a safety hazard. Then, the safety risk associated with the hazard must be determined. Once the risk is known, available safety controls and safe work procedures need to be considered. Lastly, a decision is then made on how to proceed safely. Poor assessment of the level of risk present can lead to decisions that omit needed safety controls or do not provide enough safety buffer, and therefore lead to injury incidents. In addition, when the level of risk is assessed, a high tolerance for taking on risk (e.g., “showing off” or over-confidence) may allow for too much risk in the work operation given the safety controls present. In both situations, the person evaluating the risk and making a decision on how to proceed must have a good sense of the acceptable level of risk. Appropriate training for the work operation can help to ensure that the risk assessment and actions taken result in a safe operation. Involving someone who has experience with the operation can also enable quality risk assessment.



## 4.0 CONTROLLING HAZARDS AND WORKING SAFELY NEAR OR IN TRAFFIC

Working safely requires accounting for and controlling the safety hazards that are present in a work area. There are a variety of ways to control hazards. Common types of controls are described below, in order of decreasing effectiveness and reliability:

- *Elimination*: The most effective way to control a hazard is to eliminate it from the work area. Eliminating the hazard is the most reliable method and ensures that there will be no injury incidents associated with the hazard.
- *Substitution*: If the hazard cannot be eliminated, the next best action is to substitute in a different material, process, or equipment that reduces the risk associated with the hazard.
- *Engineering*: Adding an engineering control is also a way to protect workers from hazards. There are many examples of engineering controls including guardrails, traffic lights, concrete barriers, and intrusion alert devices.
- *Administrative*: Administrative controls are a type of control that uses safe work practices and procedures to prevent workers from being exposed to hazards. Safety training and warning signs are examples of administrative controls.
- *Personal Protective Equipment (PPE)*: Lastly, personal protective equipment is a type of control that provides protection to workers to minimize the chance and severity of injury should an accident occur. It is important to note that administrative controls and PPE rely heavily on human behavior and therefore are subject to suffer from potential mistakes/errors, absent-mindedness, and other human behavior lapses.

Selecting the right control for the work operation is important to ensure safety. In many cases, safety standards have been developed and adopted for specific types of work operations. Provided below is a description of common practices and standards for working safely near or in traffic.

### 4.1 SAFETY TRAINING

All personnel who will be present in the work area should be trained on how to work next to motor vehicle traffic in a way that minimizes their vulnerability to being struck by passing vehicles. Every work zone is different. An effective worker safety orientation is necessary for workers who are new to the work operation and work area. Worker safety orientation and training should include:

- An identification of specific jobsite hazards and an explanation of the safeguards to take while in the work area;

- Information on the limitations and proper uses of traffic control devices and other protection, including the details of both the external and internal traffic control plan in place; and
- A briefing on the emergency action plan for the site.

The Appendix provides lists of available documents, websites, and videos that are designed to provide safety training for workers in roadway work zones.

## **4.2 MAKE A SAFETY PLAN BEFORE GOING ON THE SITE**

Coordinate with your lead researcher, advising professor, and/or principal investigator for the research study in advance of initiating your field work, and contact the on-site manager, foreman, or engineer before arriving to let them know that you will be on the site, ask about any safety hazards that you should be aware of, and recommendations for how to stay safe while on the site.. Work zones are different from site to site; preparation is the key to a safe and successful day. Prepare a safety plan by taking the following steps:

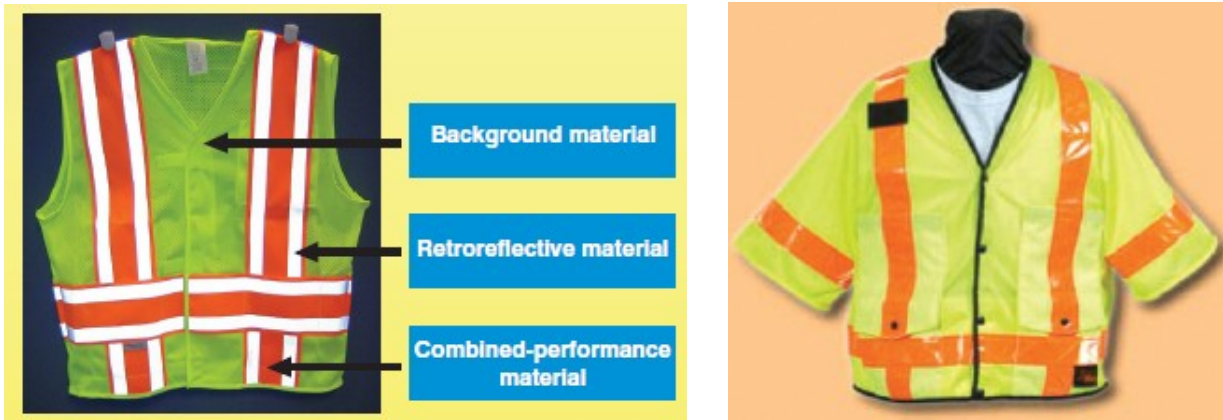
- Discuss your approach to safety with your, lead researcher, advising professor, and/or principal investigator for the study;
- Discuss your safety plan with your fellow research team members;
- Prepare for the weather – hot, dry, cold, or wet. Carry water, food, sunscreen, and bug repellent as needed;
- Coordinate with the on-site manager and ask how to access the project and where to park;
- Have an escape route planned in case of emergency; and
- Make sure you know who to contact and what to do in an emergency situation.

If something changes from your original plan after you arrive, stop and regroup. Refocus on safety, and then go ahead with the work or return home depending on the situation. Always ask questions before and after arriving on the site.

## **4.3 WORKER SAFETY APPAREL, LIGHTING, AND PERSONAL PROTECTIVE EQUIPMENT**

All workers exposed to the risks of moving roadway traffic or construction equipment should wear high-visibility safety apparel meeting the requirements of International Safety Equipment Association (ISEA) “American National Standard for High-Visibility Safety Apparel” and labeled as American National Standards Institute (ANSI) 107 standard performance for Class 1, 2, or 3 risk exposure. Accepted as appropriate warning vests or other suitable garments marked with or made of reflectorized or high-visibility material are those garments that meet the requirements of ANSI 107. The most significant aspect of the ANSI 107 standard is that it

requires 360-degree visibility, meaning the wearer can be seen from all sides. Class 2 or Class 3 are typically worn in roadway work zones. Figure 2 shows photos of Class 2 and 3 vests (ATSSA 2009).



(a) Class 2

(b) Class 3

**Figure 4.1: Class 2 and Class 3 Reflective Apparel (ATSSA 2009)**

Descriptions of the material specifications, performance levels, and working environments for each reflective apparel class based on the ANSI 107 standard are shown in Table 2 (OR-OSHA 2011).

**Table 4.1: Performance Classes for Reflective Apparel (OR-OSHA 2011)**

Performance Class	Description
1	<ul style="list-style-type: none"> <li>• Minimum background material: 217 in<sup>2</sup></li> <li>• Minimum retroreflective material: 155 in<sup>2</sup></li> <li>• Provides the minimum amount of required material to distinguish the wearer from the environment</li> <li>• Intended for workers whose tasks don't divert their attention from approaching traffic</li> <li>• Intended for locations where the worker is separated from traffic which is travelling no faster than 25 mph</li> </ul>
2	<ul style="list-style-type: none"> <li>• Minimum background material: 775 in<sup>2</sup></li> <li>• Minimum retroreflective material: 201 in<sup>2</sup></li> <li>• Provides enhanced visibility during inclement weather</li> <li>• Intended for workers whose tasks divert their attention from approaching traffic and for those who must work near vehicles travelling at speeds exceeding 25 mph</li> </ul>
3	<ul style="list-style-type: none"> <li>• Minimum background material: 1,240 in<sup>2</sup></li> <li>• Minimum retroreflective material: 310 in<sup>2</sup></li> <li>• Provides maximum visibility for workers who have tasks that place them in imminent danger from approaching traffic</li> <li>• Provides maximum visibility when the wearer must be conspicuous at a minimum distance of 1,280 feet</li> </ul>

During nighttime work, illuminating workers is imperative. The lighting can be provided by a stationary, temporary light (e.g., a light tower or a balloon light supported by a tripod), or by permanent lights in the work area. Wearable lights are also effective for increasing the visibility of workers and getting the attention of passing motorists.

#### **4.4 WORK ALONG WITH OTHER WORKERS**

When possible, do not work alone. Always work with a partner and/or spotter when you can, and avoid turning your back on traffic. If the work requires you to operate equipment, make sure you

work with a spotter who can watch the oncoming traffic for you. Always pay attention to your surroundings; turning your back on traffic is dangerous since it is hard for you to notice the potential risk of an oncoming car or nearby piece of construction equipment.

#### **4.5 LOCATION OF EQUIPMENT AND STRATEGICALLY-PLANNED EQUIPMENT OPERATIONS**

The presence of equipment can be utilized to protect workers from being struck by on-coming traffic. Additionally, strategically planning the equipment operations to take advantage of the equipment size, traffic patterns, or the location of other roadway infrastructure can help to effectively minimize exposure to passing vehicles in work areas. Keeping a large, illuminated piece of equipment close to the work area may help to get motorist's attention and make them drive more safely while passing the work area. This means of controlling hazards is especially effective in mobile work zones that contain large pieces of equipment and minimal positive protection from passing traffic (e.g., re-paving).

#### **4.6 SAFE DESIGN OF WORK AREA AND OPERATIONS, INCLUDING WARNING SIGNS AND SIGNALS**

A well-organized plan before implementing the research work process is very effective in keeping the work safe. The elimination or significant reduction of risks at the planning and design stage of tools, materials, processes, and projects, holds great promise for the reduction of safety and health risks in work operations. Safety plans should be made in advance. For the research to be undertaken, the work plan should include the research goal while out on the work site and the research steps to be undertaken. For each research step, list what the crew could do to help with your research and how to work safely. Make a reasonable safety plan, and search the surrounding environment to make sure you can keep yourself out of danger at all times. In addition, expect the unexpected while on-site; roadway work zones can contain many hazards that are not foreseen. Think safety at all times.

In many cases, researchers will work directly with construction and/or maintenance crew members working for the DOT or contractor. Be sure to follow the instructions of the working crew members. The work crew members are experienced in the work being undertaken and know the hazards present and how to mitigate the hazards. Maintain good communication with the work crews, informing them of what you need for your research, where you will be located, what you will be doing, and when you will arrive and depart. Ask the work crew members about unique safety hazards to be aware of and how to best protect yourself from the hazards.

#### **4.7 PERSONAL ELECTRONICS USE**

The use of personal electronics (e.g., cell phones, audio/video players, laptop/tablet computers) whether as part of the research or not, creates distractions. Importantly, do not use personal electronics while operating vehicles and large equipment. Make sure that the vehicle or equipment is completely stopped and out of the traffic flow and work area before using a phone, computer, or other electronic device. When you need to use a personal electronic device, remember to look up often and in alternating directions to observe your surroundings for possible safety hazards. Whenever possible, use hands-free devices or those that can be operated using

voice commands. If a phone call or text must be sent while standing on the job site, establish an anchor point to put your hand or arm on while you use the phone.

#### **4.8 PREVENTING FATIGUE AND OVEREXERTION**

Preventing fatigue and overexertion while working on site requires actions and care both while working and between work shifts. If working at night, be sure to get two full nights of sleep (at least 7 hours each night) before starting to work the night shift for the work week. If intermittent day and night work shifts are required, establish a 4-hour anchor sleep time each 24 hour period and supplement this sleep time with naps. The best naps last at least 10-12 minutes long, which are perfect for lunch breaks. Long naps (e.g., 2 hours) in the mid-afternoon prior to the night shift help reduce sleep deprivation.

#### **4.9 REACT TO ACCIDENT AND NEAR MISSES**

If an injury, vehicle accident, or near miss occurs, researchers need to contact the principal investigator, advising professor, or the research leader for the study as soon as possible. Report the incident and obtain further instructions before continuing your work. In all cases, when arriving on the site, if you do not feel safe, ask for assistance, leave the site, or regroup until a safer work method and location can be found.

## **5.0 EMERGENCY RESPONSE**

In emergency situations where medical or other assistance is needed, be sure to ask for help. For incidents involving severe injuries, call “911”. Help may also be provided by nearby crew members if the situation warrants. Prior to the start of the work, obtain cell phone numbers of the other workers on the work site if they will be a long distance from your work area. Additionally, student researchers should contact the principal investigator, advising professor, or research leader for the study as soon as possible to report the incident and obtain instructions for further action.





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## **APPENDIX A**



## A.0 ADDITIONAL RESOURCES

The following tables contain summary lists of additional resources that provide useful information about safety while working in or near traffic, and while driving in work zones.

Ref. No.	Title	Website Address	Summary Description
<b>DOCUMENTS / WEBSITES</b>			
1.1	ODOT-2016 WorkZoneFactSheet	<a href="http://www.oregon.gov/ODOT/T S/docs/Workzone/2016_WorkZoneFactSheet%2020160503.pdf">http://www.oregon.gov/ODOT/T S/docs/Workzone/2016_WorkZoneFactSheet%2020160503.pdf</a>	Useful tips for worker safety in construction work zones, including facts and guidelines for workers before entering the work zone area.
1.2	2011 Oregon Temporary Traffic Control Handbook (For operations of three days or less)	<a href="http://www.oregon.gov/ODOT/H WY/TRAFFIC-ROADWAY/docs/pdf/2011_OTTCH.pdf">http://www.oregon.gov/ODOT/H WY/TRAFFIC-ROADWAY/docs/pdf/2011_OTTCH.pdf</a>	General standards and practices for temporary traffic control in short-term work zones, including incident traffic control.
1.3	Intersection Safety - A manual for local rural road owners	<a href="http://safety.fhwa.dot.gov/local_rural/training/fhwasa1108/fhwasa1108.pdf">http://safety.fhwa.dot.gov/local_rural/training/fhwasa1108/fhwasa1108.pdf</a>	Intersection safety for local rural road owners, along with some traffic control standards such as the placement of the warning signs.
1.4	Roadway Departure Safety - A manual for local rural road owners	<a href="http://safety.fhwa.dot.gov/local_rural/training/fhwasa1109/fhwasa1109.pdf">http://safety.fhwa.dot.gov/local_rural/training/fhwasa1109/fhwasa1109.pdf</a>	Roadway departure safety for local rural road owners. Identifies some safety issues and lists several case studies.
1.5	Road Safety Information Analysis - A manual for local rural road owners	<a href="http://safety.fhwa.dot.gov/local_rural/training/fhwasaxx1210/lrro_data.pdf">http://safety.fhwa.dot.gov/local_rural/training/fhwasaxx1210/lrro_data.pdf</a>	Road safety for local rural road owners, focusing mainly on data analysis and case studies.
1.6	OSHA - Highway work zones and signs, signals, and barricades	<a href="https://www.osha.gov/doc/highway_workzones/">https://www.osha.gov/doc/highway_workzones/</a>	Lists all of the related regulations on highway work zones and sign, signal, and barricade placements to ensure construction work zone safety.
1.7	Building Safer Highway Work	<a href="http://www.cdc.gov/niosh/docs/2">http://www.cdc.gov/niosh/docs/2</a>	Describes injury prevention measures for workers

	Zones: Measures to prevent worker injuries from vehicles and equipment	<a href="http://001-128/pdfs/2001-128.pdf">001-128/pdfs/2001-128.pdf</a>	in highway work zones.
1.8	OSHA Instruction – Inspection and citation guidance for roadway and highway construction work zones	<a href="https://www.osha.gov/OshDoc/Default.aspx?DocID=CPL_02-01-054.pdf">https://www.osha.gov/OshDoc/Default.aspx?DocID=CPL_02-01-054.pdf</a>	General enforcement policy and guidance to assist OSHA compliance personnel in safely inspecting work sites where employees are engaged in construction work on and near roadways.
1.9	Manual on Uniform Traffic Control Devices for Streets and Highways – 2009 Edition with 2012 Revisions	<a href="http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/mutcd2009r1r2edition.pdf">http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/mutcd2009r1r2edition.pdf</a>	Detailed information on signs, markings, highway traffic signals, and many other traffic control devices and procedures to work zone safety on roadways.
1.10	Work Zone Hazards Awareness Workbook, Construction Safety Council, Hillside, IL.	<a href="https://www.osha.gov/dte/grant-materials/fy08/sh-17795-08/workzone_hazards_awareness_english.pdf">https://www.osha.gov/dte/grant-materials/fy08/sh-17795-08/workzone_hazards_awareness_english.pdf</a>	Illustrates different solutions/reactions to work zone safety hazards while dealing with different surroundings and conditions in roadway work zones.
1.11	Work Zone Safety Grant, ATSSA	<a href="http://www.atssa.com/WorkZoneSafetyGrant#Videos_Grant">http://www.atssa.com/WorkZoneSafetyGrant#Videos_Grant</a>	A website that lists a series of videos for construction work zone safety training.
1.12	Guidance Documents, ATSSA	<a href="http://www.atssa.com/WorkZoneSafetyGrant/GuidanceDocs">http://www.atssa.com/WorkZoneSafetyGrant/GuidanceDocs</a>	A website that lists safety guidance documents for different kinds of work zones. The guidance documents could be a part of safety training.
1.13	OSU Safety (SAF) Manual	<a href="http://fa.oregonstate.edu/saf-manual">http://fa.oregonstate.edu/saf-manual</a>	Oregon State University regulations on general safety, workplace safety, and laboratory safety for students, faculty, and staff.
1.14	Flagger Training – Chemeketa Community College	<a href="http://www.chemeketa.edu/busprofession/ccbi/customizedtraining/flagger.html">http://www.chemeketa.edu/busprofession/ccbi/customizedtraining/flagger.html</a>	A website that describes flagger certification training courses provided by Chemeketa Community College.
1.15	Roadside Worker Safety, Environmental Health and Safety, Boston University	<a href="http://www.bu.edu/ehs/files/2012/02/Roadside-Worker-Safety-clean-10.11.pdf">http://www.bu.edu/ehs/files/2012/02/Roadside-Worker-Safety-clean-10.11.pdf</a>	A roadside worker safety manual for employees performing work on or in close proximity to roadways. Ensures that workers are properly equipped with high visibility safety apparel and warning devices, and have the appropriate training and knowledge to properly plan for roadside work.
1.16	WSDOT - Roadside Safety	<a href="http://www.wsdot.wa.gov/publica">http://www.wsdot.wa.gov/publica</a>	Chapter 310 mainly refers to roadside safety,

		<a href="#">tions/manuals/fulltext/M25-30/310.pdf</a>	including safety of vehicle occupants as well as worker and pedestrian safety.
1.17	USDOT - Worker Safety	<a href="http://www.ops.fhwa.dot.gov/Wz/workersafety/index.htm">http://www.ops.fhwa.dot.gov/Wz/workersafety/index.htm</a>	A website that provides comprehensive information about working safely in roadway work zones, including worker visibility regulations, temporary traffic controls, and training strategies.
1.18	Wisconsin DOT - Work Zone Safety	<a href="http://wisconsindot.gov/Pages/safety/education/workzone/default.aspx">http://wisconsindot.gov/Pages/safety/education/workzone/default.aspx</a>	A website that provides workers safety tips and guidance while working in the field.
1.19	OSHA Fact Sheet	<a href="https://www.osha.gov/OshDoc/data/Hurricane_Facts/work_zone_traffic_safety.pdf">https://www.osha.gov/OshDoc/data/Hurricane_Facts/work_zone_traffic_safety.pdf</a>	A fact sheet published that lists safety guidelines for on-site construction work.
1.20	Indiana DOT - Work Zone Traffic Control Guidelines 2013	<a href="http://www.in.gov/indot/files/WorkZoneTCH.pdf">http://www.in.gov/indot/files/WorkZoneTCH.pdf</a>	A guideline for traffic control in work zones, including short-term stationary, short duration, and mobile operation situations.
1.21	Vehicle Backing Safety Factsheet	<a href="http://www.tdi.texas.gov/pubs/videoresource/fsvehiclebackin.pdf">http://www.tdi.texas.gov/pubs/videoresource/fsvehiclebackin.pdf</a>	A fact sheet intended to remind and educate people on the information needed for safely backing up a vehicle.
1.22	Drive Sober. The Way to Go		A brochure that points out how to spot an impaired driver, and the importance of not having alcohol and drugs while operating a vehicle.
1.23	Slow Down. The Way to Go	<a href="http://www.oregon.gov/ODOT/TSD/docs/Enforcement/SpeedBro.pdf">http://www.oregon.gov/ODOT/TSD/docs/Enforcement/SpeedBro.pdf</a>	A brochure designed to remind drivers to slow down while driving. Lists the penalties and potential risks of speeding.
1.24	Respect the Zone. The Way to Go.	<a href="http://www.oregon.gov/ODOT/TSD/docs/Workzone/330453_Fines_Double_24-7_737-3527_04-2014.pdf">http://www.oregon.gov/ODOT/TSD/docs/Workzone/330453_Fines_Double_24-7_737-3527_04-2014.pdf</a>	A brochure to educate drivers on why fines are doubled in work zones, and why it is important to slow down while passing a work zone.
1.25	Slow Down. Follow the Signs to Safety	<a href="http://www.oregon.gov/ODOT/TSD/docs/Workzone/WZ_brochure%20REV514.pdf">http://www.oregon.gov/ODOT/TSD/docs/Workzone/WZ_brochure%20REV514.pdf</a>	A brochure that gives an infographic study about the signs that appear in construction work zones.
1.26	Don't be a Flight Risk. Buckle Up		A brochure that illustrates the importance for drivers and passengers to use their seatbelts while

			traveling in vehicles.
1.27	Winter Travel Tips and Information	<a href="https://www.oregon.gov/ODOT/COMM/Pages/winterdriving.aspx">https://www.oregon.gov/ODOT/COMM/Pages/winterdriving.aspx</a>	A website that points out how drivers should behave when experiencing different weather situations during the winter.
1.28	ODOT Safety Calendar		A calendar that provides several safety tips on the cover each month.

Ref. No.	Title	Website Address	Summary Description
<b>VIDEOS</b>			
2.1	Oregon DOT - It Can Be a Dangerous Job	<a href="https://www.youtube.com/watch?v=yEGkcseNmqA">https://www.youtube.com/watch?v=yEGkcseNmqA</a>	A video showing a police officer, based on his own experiences, telling the public that roadside work is a dangerous job, and reminding people to be more careful while passing a working area.
2.2	Purdue University - Student Roadside Safety Training	<a href="https://www.youtube.com/watch?v=cOmh_8aiud4">https://www.youtube.com/watch?v=cOmh_8aiud4</a>	A video that shows student workers how they should behave when preparing for and working in roadside work zones.
2.3	Norton Construction - Norton Road Construction Work Zone Safety	<a href="https://www.youtube.com/watch?v=0QBxt1BJwj0">https://www.youtube.com/watch?v=0QBxt1BJwj0</a>	A video to train workers and employees who are working in roadside work zones to reinforce their safety.
2.4	Work Zone Safety Traffic Control Devices	<a href="https://www.youtube.com/watch?v=ZWBQHpCfvEo">https://www.youtube.com/watch?v=ZWBQHpCfvEo</a>	A video that illustrates the placement and operation of different warning signs and traffic control devices.
2.5	PublicResourceOrg - One Step from Death	<a href="https://www.youtube.com/watch?v=Lx53sAiZLeM">https://www.youtube.com/watch?v=Lx53sAiZLeM</a>	Videos of workers sharing their stories about former accidents, trying to tell people to be careful while driving past work zones.
2.6	TowingTV - Roadside Accidents	<a href="https://www.youtube.com/watch?v=mqqZre9Xxpw">https://www.youtube.com/watch?v=mqqZre9Xxpw</a>	Some posted videos of roadway accidents captured by road security cameras. Warns the public to be more careful while driving.
2.7	NYSDOT - A Family's Grief - Your Car is Like a Weapon	<a href="https://www.youtube.com/watch?v=kHfX5ia74qY">https://www.youtube.com/watch?v=kHfX5ia74qY</a>	A video depicting a family's grief due to a fatality accident. Instructs drivers to slow down while



			passing work zones.
2.8	Roadworker Safety - Silence is Consent (Part 1 and Part 2)	<a href="https://www.youtube.com/watch?v=oAvrFYkP3P0">https://www.youtube.com/watch?v=oAvrFYkP3P0</a>	This video aims to persuade workers to report unsafe behavior and conditions as soon as possible. Keeping silent is another way to show consent to an unsafe situation.
2.9	Work Zone Safety News - TDOT workers	<a href="https://www.youtube.com/watch?v=tQ_HONQaAAQ">https://www.youtube.com/watch?v=tQ_HONQaAAQ</a>	A recorded television news broadcast that talks about a roadway fatality accident and provides some analysis on the reasons for the accident.
2.10	Stay Alert Stay Alive - Work Zone Safety 2012	<a href="https://www.youtube.com/watch?v=Xk1yTLj02vw">https://www.youtube.com/watch?v=Xk1yTLj02vw</a>	This video lists several useful tips for construction workers to be safe in roadway work zones.
2.11	Flagging - Safety Is In Your Hands	<a href="https://www.youtube.com/watch?v=3OCIA3jv-s">https://www.youtube.com/watch?v=3OCIA3jv-s</a>	The video is mainly about flagger training, what flaggers should do, and what flaggers should not do while working in roadside work zones.