Utility Work Zone Safety Guidelines and Training

Gap Study and Needs Assessment

Prepared for:
United States Department of Transportation
Federal Highway Administration
Washington, D.C.

Prepared by:
Wayne State University
Transportation Research Group
Detroit, MI

Date: August 2007

U.S. Department of Transportation
Federal Highway Administration

WAYNE STATE UNIVERSITY

Utility Work Zone Safety Guidelines and Training

Gap Study and Needs Assessment

RFA Number DTFH61-06-G-00006
CFSA Number: 20.200

Submitted to:
United States Department of Transportation
Federal Highway Administration
HSA Room #E71-324
1200 New Jersey Ave. SE
Washington, D.C. 20590

Contractor:
Wayne State University
Transportation Research Group
Civil & Environmental Engineering
Schaver Building, Room #208
5451 Cass Avenue
Detroit, MI 48202

Sub Contractor:
Bradley University
Civil Engineering and Construction
1501 W. Bradley Avenue
Peoria, IL 61625

Date: August 2007

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF PHOTOGRAPHS

1.0 INTRODUCTION

Utility work zones are different as compared to normal highway construction work zones. They are shorter in duration and often unplanned; as a result, there are a different set of risks associated with utility work zone traffic control. In order to develop utility work zone traffic control guidelines and a curriculum for the training program, it is essential that the gaps in the state-of-the-art of temporary traffic control-related research studies and the needs of highway utility work zone worker and passing motorist protection requirements, be identified. Also, it is important to recognize the deficiencies in the practice, gaps in the existing standards and training materials related to utility work zones.

Utility work often requires the intrusion of construction equipment/van on the roadway, shoulder and/or within the right-of-way of existing roads and highways. Although utility work is generally less time consuming than traditional road work, it still poses similar challenges to the passing motorists and workers. The Manual on Uniform Traffic Control Devices (MUTCD) provides some general guidelines for utility work zones. However, significant flexibility exists in these guidelines that is often interpreted in many different ways by utility companies/contractors/road agencies that create non-uniformity, which results in heightened risks for both motorists and workers.

The proposed guidelines and training will focus on utility work zone activities and mitigating safety challenges that are often present in these work zones. The guidelines and training will be developed to include gaps that are found in current guidelines/standards and training programs, needs that are identified through past literature searches and current practice surveys, interviews of safety officials, information collected during work zone site visits and utility worker surveys. The following sections describe the data that was collected and the gaps that were found, which were used to assess the needs of the proposed utility work zone guidelines and training.

2.0 GAP STUDY

2.1 State-of-the-Art Gap Study

A State-of-the-Art Synthesis was performed for topics related to utility work zone temporary traffic control and safety as a part of a previous deliverable for this task. This report indicated

several gaps that need to be addressed in the proposed guidelines. The number of crashes and fatalities in utility work zones are relatively low as compared to normal highway construction and maintenance work zones. According to the Fatality Analysis Reporting System (FARS), utility work zones represent one (1) to two (2) percent of the overall annual work zone fatalities [1]. Due to the low number of fatalities, research on utility work zones has not been as intense as in the area of highway construction and maintenance work zones. There is also an under representation of utility work zone crashes due to inconsistencies in crash reporting forms. Some crash report forms have a specific space/area to indicate whether the crash occurred within a work zone, while others do not [2]. Typically, utility work zone crashes are underreported, and, therefore, it is difficult to tell how many of these crashes are specifically occurring in utility work zones. In addition, some crash report forms do not differentiate between the types of work zones, whether it is construction, maintenance or utility work that was being conducted at the time the crash occurred.

Most state agencies, utility companies and contractors follow the guidelines of the MUTCD for utility work zone traffic control. The MUTCD (Section 6G.02) differentiates between the various durations of work in the following ways:

A. **"Long-term stationary** is work that occupies a location more than 3 days
B. **Intermediate-term stationary** is work that occupies a location more than one daylight period up to 3 days, or nighttime work lasting more than 1 hour
C. **Short-term stationary** is daytime work that occupies a location for more than 1 hour within a single daylight period
D. **Short duration** is work that occupies a location up to 1 hour
E. **Mobile** is work that moves intermittently or continuously" [3].

Even though the MUTCD makes mention of short duration work, sufficient research has not been performed for this category of work. The current categorization of work durations in the MUTCD may not have been based on objective research. Short duration work zones are not defined in detail and the issues related to short duration work zones have not been adequately addressed. Additional hazards and risks should be recognized and managed in an efficient manner minimizing risk, yet providing mobility and safety to both motorists and workers.

The risks associated with short-term stationary and short duration work zones are also not well substantiated by past research; thus, utility work zone traffic control is critical in terms of safety consequences. The difference between these two time based categories may only be a matter of minutes, yet require a significantly different traffic control treatment according to the provisions in the current MUTCD. It is often difficult to define a work zone by the duration of work, especially when the time period is short and may vary due to the site conditions and/or efficiency of the work crew. A job may take 50 minutes to complete and, therefore, would be classified as short duration; however, the same job in a different location and/or by a different crew may take 90 minutes to complete and it would be classified as a short-term stationary work zone. This was observed in a study conducted in Michigan [4]. Also, the efficiency of the utility crew might play a vital role in the amount of time a job takes to complete. The same company may have one crew that is very experienced and may only take 30 minutes to complete a job, while another crew may be less experienced and need an hour to complete the same type of job. It may not matter if the same type of job at a similar location takes 50 minutes or 90 minutes to complete, since the same type and location of work creates similar risks. In both cases, the same temporary traffic control should be required. A utility work zone located on the roadway will have much greater risk than a utility work zone located 30 feet away from the edge of the pavement. The temporary traffic control should correspond to the risks associated with each type of utility work zone site.

Sometimes, the duration of a utility work zone cannot be correctly determined before the work begins. At the beginning of a job, the work may be considered short duration; however, as the work commences, the duration may turn into short-term stationary due to unforeseen site specific issues. At this point, the workers are not going to set-up a new traffic control that corresponds with the new work durations. Because of these duration related issues, the guidelines should be based on the **type of work and the location and type of roadway**, rather than the time duration, especially when it is relatively short.

Utility work normally falls in the short-term stationary, short duration or mobile work zone categories, which causes a variety of safety challenges for the workers and also the passing motorists. A better definition of the possible utility work would help the utility companies, and

the workers will have a better understanding of the temporary traffic control required for each specific job. According to a current practices survey of state Departments of Transportation (DOTs) conducted by Ullman, Finley and Trout [5], the perception of the definition of short duration work varied among the different agencies. Some definitions of short duration work, according to the agencies, may be less than 15 minutes or up to 12 hours.

For the short duration of utility work zones, it may sometimes take longer to set-up and remove the temporary traffic control devices than to actually complete the work. This puts the utility workers exposed to the passing motorists and at risk for an additional time period. Many safety professionals think it is unnecessary to require utility workers to use elaborate temporary traffic control that takes a long time to set-up. The workers are directly exposed to passing vehicles which may result in a higher chance of a crash occurrence. According to the noted study [5], many agencies are aware of this issue and address it by allowing their utility workers to use less extensive traffic control and larger, moveable devices. These larger, moveable devices may include Truck Mounted Attenuators, Portable Changeable Message Signs (PCMs) and mobile work vehicles with warning lights [6]. Some utility companies use an oscillating light on the top of their vehicle for work in the short duration category. This is supported in the MUTCD (Section 6G.02, page 6G-2). While most utility companies and contractors use such warning lights, there is no uniformity among them and, therefore, motorists have the challenge of recognizing these utility work zones.

Utility work in urban areas poses additional challenges. Past research has been conducted in urban work zones [7, 8], but not specifically for urban utility work zones. The frequency of intersections, multiple distractions from commercial developments, presence of pedestrians, high traffic volumes and high speeds, increases the risk of traffic crashes as compared to utility work zones in rural areas or in residential subdivisions. Utility work in urban areas is also much greater in frequency than in rural areas.

Past studies have indicated that some traffic control devices are more effective than others in terms of motorist perception and response. Currently, there are no national standards for warning lights and arrow panels for utility work zones. There are numerous types of these

devices available that are being used in utility work zone traffic control. In the Traffic Control Handbook for Mobile Operations at Night Guidelines for Construction, Maintenance and Utility Operations published by FHWA [9], various traffic control devices including warning lights and arrow panels are discussed for their use at night. However, no guidelines are mentioned for their use during daytime operations. According to these guidelines, the color of the warning lights, the type of lights, and where they are mounted on the vehicles have an impact on their visibility to passing motorists. Since characteristics are different during the day than at night, separate guidelines should be developed for daytime use. According to a study conducted by Ullman [10], the intensity of the lights and the way in which they flash, determines the effectiveness of the lights. Guidelines for the use of warning lights and arrow panels for utility work zone traffic control should be available so that the utility companies and contractors use their devices in the most effective manner. Kamyab and McDonald conducted a current practices survey of 34 state DOTs and 61 Iowa county agencies and found that "All contacted state DOTs use at least, if not exclusively, amber warning lights. Some states use a combination of warning light colors on their maintenance vehicles." [11] The survey results also indicated that "Most warning lights used on state maintenance vehicles are either rotating or strobe lights. Strobe lights are the most common type used by the state DOTs" [11] The authors stated that "The MUTCD does not specify what color or kind of warning lights to use, which is one reason why there is a wide variety of lights used on maintenance vehicles." [11] These survey results show that there are inconsistencies between the devices that different state DOTs use; therefore, there is a need for guidelines to specify details about the devices, such as the color and the type of warning lights that should be used.

There should be national guidelines for the use of illuminated arrow panels. According to Knapp and Pain, the way the arrow panel flashes, including the rate at which it flashes, affect the way the message is interpreted by motorists [12]. According to Griffith and Lynde [13], the type of arrow panel display used, such as a sequentially flashing diamond mode, flashing line or flashing four-corner, also affects the way motorists interpret the message. Guidelines should be developed to provide utility companies and contractors with recommendations in the use of arrow panels. The guidelines should provide ways to utilize the arrow panels so that they are

correctly and uniformly used thus, increasing the chance of proper interpretation by passing motorists and pedestrians.

The importance of the worker and pedestrian safety should also be addressed in the guidelines for utility work zone traffic control. The visibility of utility workers to the motorist is very important. According to a study conducted by Turner, Simmons and Graham, fluorescent red-orange safety vests are the most visible to motorists [14]. The safety of pedestrians walking through or around the work zone is also very important. If a sidewalk is closed, a safe path should be identified for pedestrians to follow.

Existing training programs were also researched as a part of the State-of-the-Art Synthesis. It was found that there are many work zone safety-related training programs that currently exist; however, there are only a few that focus specifically on utility work zones. Utility work zone safety training should be separated from the normal construction and maintenance work zone safety training. The unique issues that exist in utility work zones, including the short duration of work, should be emphasized in such a training program.

2.2 State-of-the-Practice Gap Study

In the State-of-the-Practice Synthesis submitted to the Federal Highway Administration, a current practices survey of the utility companies and contractors was conducted. The results of this survey are included in Appendix I. A summary of these results, which establish the need for utility work zone guidelines, are included in the following paragraphs.

The current practices survey was completed by 27 utility companies and contractors. These companies perform work in more than half of the states in the USA. According to the survey, 93 percent of the responding companies have developed their own standards for temporary traffic control in utility work zones. Those companies that have developed their own standards for temporary traffic control were asked about the provisions of their specific standards. Of those respondents who have developed their own standards, 59 percent stated that they have standards based on the duration of utility work, 78 percent of the respondents have standards based on the utility work location, 33 percent of the respondents have standards based on the

type of work and 74 percent of the respondents have standards based on the type of roadway. As a result, it can be concluded that most utility companies either follow, or perceive they follow, different standards depending on where the utility work is taking place and on what type of roadway the work is being performed. Most of these companies refer to or follow the language of the MUTCD and state design manuals as their standards for utility work zones. However, an on-site review of utility work zone investigations, conducted as a part of this task and described later in this section, shows a widespread non-uniformity of traffic control devices that are being used in the field.

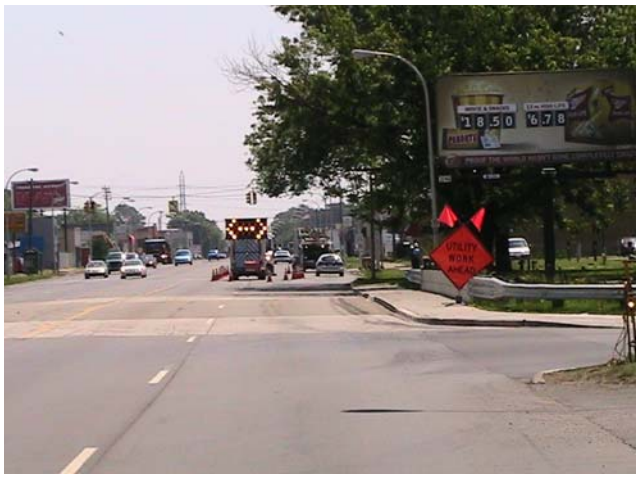
According to the survey, 85 percent of the responding utility companies and contractors offer training programs for utility work zone traffic control and 81 percent of the companies and contractors conduct periodic process reviews of their utility work zone programs. The survey also included questions related to crashes within the work zone and tort liability cases involving the company within the past five years. It was found that 44 percent of the responding utility companies and contractors have been involved in utility work zone-related crashes, injuries or fatalities in the past, and 11 percent of the respondents have been involved in tort liability cases. It was found that 41 percent of the companies and contractors have been subjected to reviews and/or citations from the local Occupational Safety and Health Administration (OSHA) for worker safety violation issues.

As a part of this task, on-site investigations of local utility sites in the states of Michigan, Ohio and Illinois were conducted. During these on-site investigations, digital photographs and videos where allowed, were taken at each site to document what was observed and may be used to develop case studies to teach “Dos and Don’ts” in the training program. A checklist including information regarding the temporary traffic control at each of the work zones was completed as a part of the on-site investigation. A copy and summary of the checklist from the on-site investigations is included in Appendix II.

It was found during the on-site investigations that the temporary traffic control for each work zone was sometimes different. Even work zones from the same company differed from one another. One of the reasons for this is that the duration and location of the work varied from site

to site. Some work zones were less than an hour, while others were there for a couple of days and some were located on local roads (Photograph 1) with low speeds, and others were located on urban arterial roadways (Photograph 2) with higher operating speeds. The longer duration work zones and the work zones on higher speed roadways had appropriately more elaborate traffic control than the work zones that were only there for one hour and/or on local/residential roadways. Most of the work zones that were on local, low speed roads used one "Utility Work Zone Ahead" sign (Photographs 3 and 4) and multiple cones around their work vehicles and equipment trailer. The work zones on higher speed roads made use of Flashing Arrow Panels, several warning signs and a greater number of cones.

Photograph 1. Utility Work Zone on Local Roadway



Photograph 2. Utility Work Zone on Urban Arterial Roadway

Photograph 3. Utility Work Zone on Local Roadway with "Utility Work Zone Ahead" Sign and Cones

Photograph 4. Utility Work Zone on Local Roadway Making Use of Cones

When cones were used in the work zone sites, they were spaced around the work vehicles/vans, equipment and equipment trailer (Photograph 5). In work sites where equipment trailers were used, some were left in vulnerable locations (Photograph 6) where they could easily be hit by errant vehicles. The equipment trailers were located behind the worker's vehicles, instead of in front of the vehicles where the work vehicle/van could shield the workers and the equipment from the approaching traffic.

Photograph 5. Utility Work Zone Making Use of Cones and Workers Wearing Safety Vests

Photograph 6. Utility Work Zone with Equipment Trailer in Vulnerable Location

Utility work zones on local, low speed roadways had the work van/vehicle and equipment trailers closer to the direction of travel along which the work van/vehicle was parked. Even when the work van/vehicle and the equipment trailer were parked on the shoulder, the direction of travel in close proximity posed a higher risk for crashes and, therefore they should be protected from errant vehicles with the use of proper traffic control devices.

Most of the time, the utility workers wore safety vests (Photograph 5, page 8), protective eyewear and hard hats. However, it was observed that there were workers not always wearing safety vests at seven of the 25 sites investigated as a part of this study. Two of those seven sites were located within the roadway with work being performed underground. Not wearing safety vests puts workers at a very high risk of being involved in a crash, since they may not be easily spotted by passing motorists or by workers operating machinery/equipment in the work zone. A study conducted of worker safety issues during nighttime construction work zones found that "the poor visibility of the workers plays an important role in accidents". [15] The authors note

that when workers are wearing a ‘well-designed’ safety vest, “the frequency and severity of nighttime accidents can be reduced” and “it is possible to improve workers’ job satisfaction, motivation and labor relations”. [15]

It was found that most of the worker’s vehicles/vans were equipped with oscillating or flashing lights, but frequently these lights were not turned on (Photograph 4, page 8). The warning lights are an additional way of attracting motorists’ attention to a work zone ahead, but if the lights are not turned on, they are useless. It was also observed that the lights on most of the vehicles were different. There should be guidelines for the standardization of lights that are required to be used on utility work vans/vehicles.

One of the utility work zones visited had orange colored work vehicles (Photograph 7). These vehicles were involved in working in the middle of the roadway, so the color of the vehicles provided additional warning to passing motorists regarding the presence of the work zone. The orange vehicles along with the oscillating lights can easily be seen by approaching motorists and provides necessary information to drivers.

Photograph 7. Utility Work Vehicle Painted Orange

One of the utility work sites that was visited was located on a two-lane rural highway (Photograph 8). The utility workers were working on the electrical poles located on the side of the highway. They parked their work vehicles in the roadway completely closing off one of the lanes to through traffic, without providing warning of the lane closure to motorists. Utility workers need to understand the importance of providing information to motorists to ensure both their and the motorists safe.

Photograph 8. Utility Work Zone Blocking One-Lane of Traffic on a Two-Lane Rural Highway

In order to have a better understanding of the guidelines that utility workers follow, and the training programs that utility workers participate in, a sample of utility workers were interviewed during the on-site investigations. A total of 64 interviews of the workers were conducted as a part of this study. Utility workers were asked questions related to the type of work they do, the temporary traffic control guidelines that they follow, and the safety training they receive. A list of the questions and a summary of the answers are included in Appendix III.

Most of the utility workers that were interviewed predominantly performed work involving gas lines (71.9%), some performed electrical work (21.9%), others worked on water mains (3.1%), and the rest did work on traffic signals (3.1%). The duration of time spent at a work site, varied by the site and type of work being conducted. The typical durations of utility work found through the interviews is shown in Figure 1.

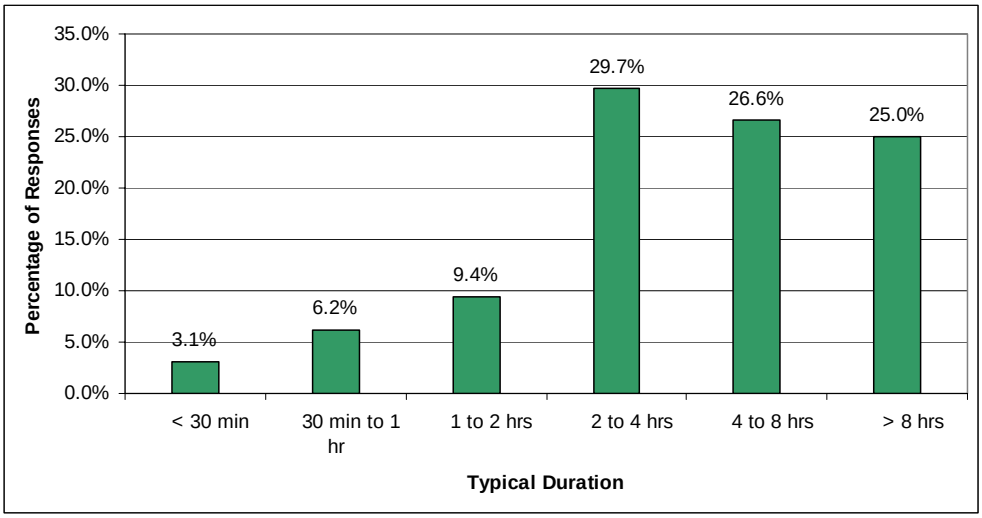


Figure 1. Typical Duration of Utility Work Conducted by the Utility Workers Interviewed

When asked how long it takes to set-up and remove temporary traffic control, each worker had a different perception of the duration of time required for their temporary traffic control set-up and removal. Workers at the same work site indicated different lengths of time to set-up, or remove the temporary traffic control devices. The time required depended greatly on what type of traffic control device they used. The more elaborate traffic controls consisting of multiple signs and cones took much longer to set-up, as compared to the simple traffic controls that consisted of oscillating lights mounted on the work van/vehicle and/or some cones. The typical time needed to install and remove the temporary traffic control, according to the utility workers, is shown in Figure 2.

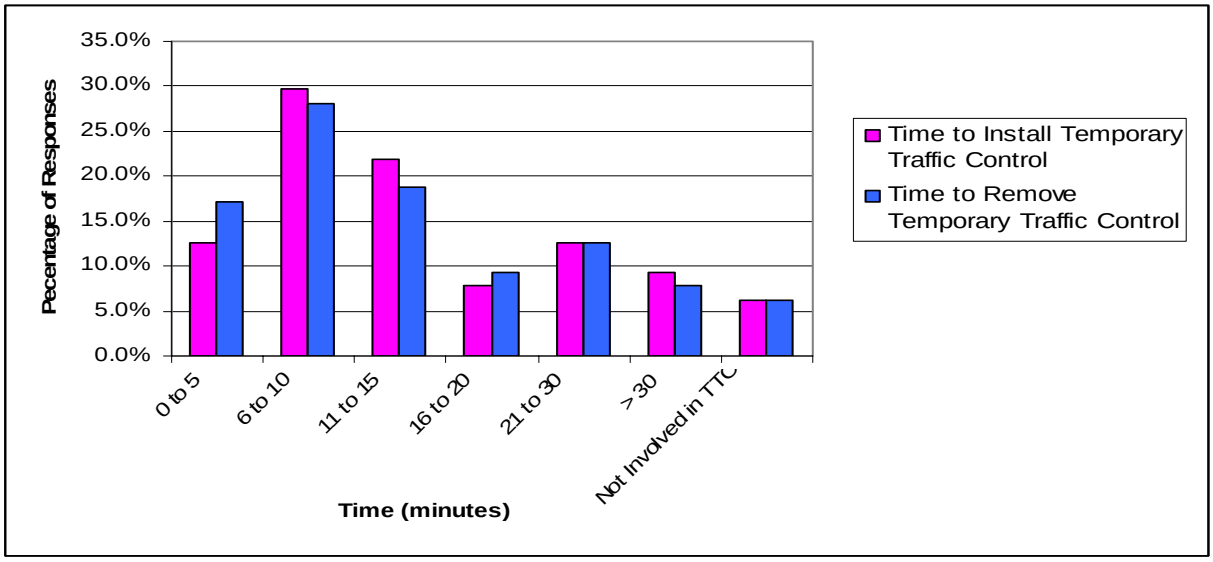


Figure 2. Time to Install and Remove Temporary Traffic Control According to the Utility Workers Interviewed

Utility workers were asked about the traffic control guidelines they follow. It was found that the majority of the workers said that they follow the MUTCD (87.5%). When asked if their company has established separate guidelines for temporary traffic control, most of the survey respondents said that their companies had not (57.8%). For those workers who claim that they have guidelines provided by their company, it was found that most of the guidelines that the workers were referring to were the MUTCD, or some excerpts from it, converted into a field manual that the workers could carry with them in their work vehicles. The utility workers were also asked how often they follow these temporary traffic control guidelines provided by their companies. More than half stated that they follow them all the time (59.4%).

The utility workers were also asked, "Do you feel that the standards/guidelines are good?" (Q. 8, Appendix III) It was found that the majority either strongly agree (14.0%) or agree (57.8%) with the question. Those that have neutral feelings towards the question (21.9%) agree that temporary traffic control is needed for their own personal safety and for the safety of the motorists, but do not agree with every aspect of the suggested traffic control set-ups. The main thing that utility workers disagreed on was the number of devices needed for setting up a utility work zone. They contend that the time spent setting up and removing the temporary traffic control could be used working on the job. Figure 3 demonstrates the responses to question No. 8 (Appendix III) of the utility worker interviews during the on-site investigations.

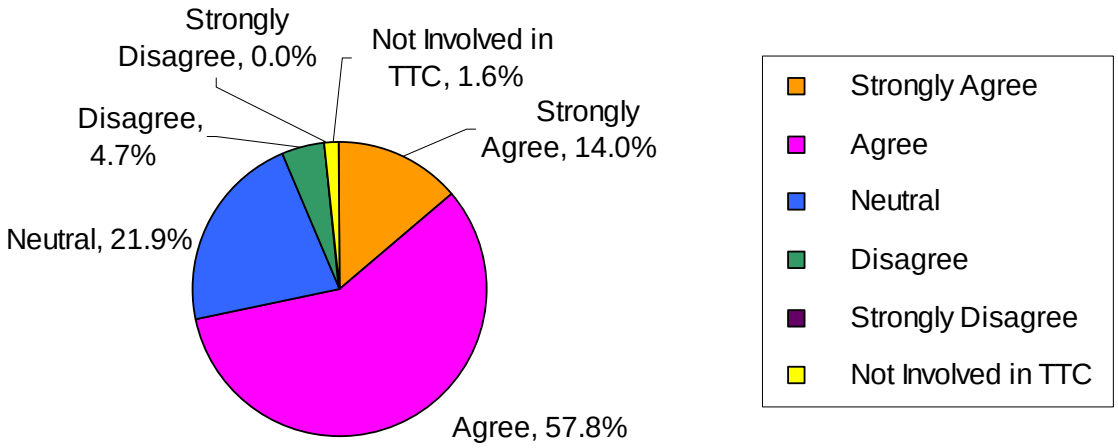


Figure 3. Utility Workers Feelings towards Temporary Traffic Control Guidelines

A large percentage of the utility workers (96.9%) claim that they are required to have some type of safety training. Some companies require their workers to participate in such training once a year, while others said that their employer required it, but could not remember the last time they attended any work zone safety training.

The most common format of the training program received by the workers was a one-day course (59.4%), once a year (65.6%). The course they are required to take not only covers utility work zone temporary traffic control, but also other issues related to worker and work zone safety. Some of the companies would also have safety talks and/or meetings with their employees, multiple times a year to keep them updated on new issues and refresh their memories about what

they had learned in the training program. These talks typically lasted an hour or two, and focused on any issue related to work zone or worker safety. None of the workers thought that their safety performance was bad and most felt (73.5%) that it was better as a result of the safety training programs they attend.

Since utility work zone temporary traffic control guidelines will be developed as a part of this grant, utility workers were asked in what format they prefer their guidelines to be in, for use in the field. A smaller field manual, which is small enough to fit in the worker's pocket and is easily accessible, was the most popular (54.7%) answer, followed by a laminated poster (37.5%). These results are displayed in Figure 4.

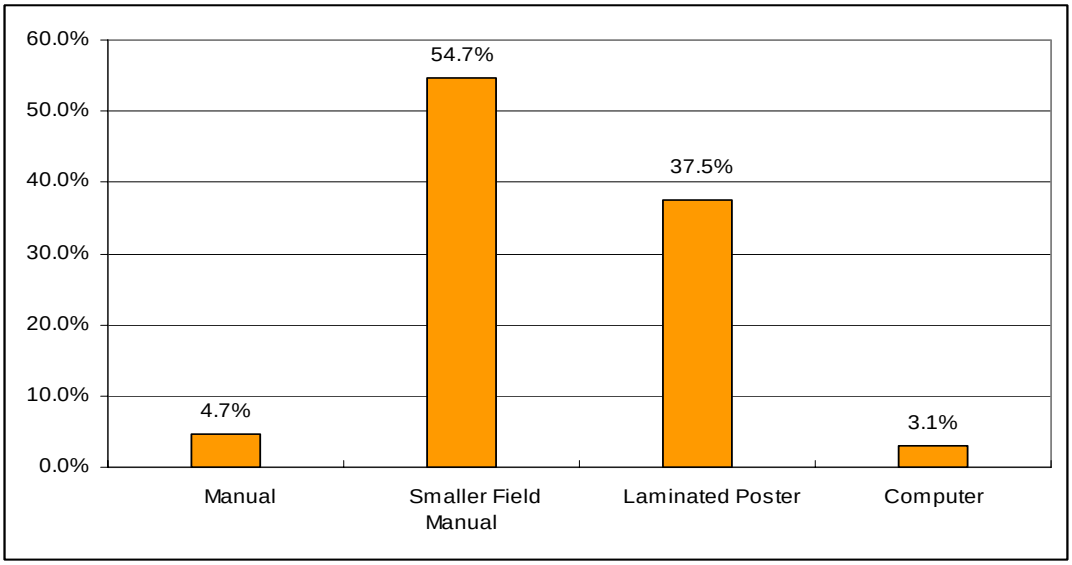


Figure 4. Preferred Format for Temporary Traffic Control Guidelines According to Utility Workers Interviewed

The last question in the survey was about whether or not utility workers have access to additional work zone safety material. Of those that do have access to additional safety material (87.5%), the majority of the workers (84.5%) can get this information from their company. It seemed that most companies have people that their workers can go to for additional information, such as their safety supervisors. In addition to obtaining information through the company, most workers are not aware that they can find information online or from other resources outside of what is provided through their company.

3.0 NEEDS ASSESSMENT

3.1 Needs Assessment for Utility Work Zone Guidelines

As determined in the gap study, there are many issues that should be included in the proposed utility work zone guidelines and training program. The utility work zone guidelines need to include specific safety issues related to utility work zones and should be based on the type of roadway and the speed of the roadway, since they often relate to crash occurrence and severity. Each state, county, and city may have additional requirements that they insist on being followed. There is a need for standard guidelines that everyone follows, so that there is uniformity of treatment in similar utility work zone situations.

The guidelines need to be proactive in reducing the number of crashes, injuries and fatalities in utility work zones. In the development of the guidelines, the importance of improving the safety of the utility workers and motorists, by preventing crashes, needs to be highlighted. Preventing crashes is a difficult task to accomplish. Often they are a result of human behavior, which is not easily changed. All appropriate measures should be taken to warn motorists of an approaching work zone.

There is also a need for standardization of equipment used in utility work zones. Warning lights and arrow panels are common for temporary traffic control for utility work zones and should be standardized. For work lasting less than an hour, warning lights on the work vehicles is an acceptable method of traffic control. Research has been performed in the area of warning lights and it has been found that certain colors and types, as well as location on the vehicle, can be seen more clearly by approaching motorists. Standards should be provided for the use of warning lights. There should also be standards for the use of arrow panels. The size, height, and the way in which the lights flash have an impact on the perception of the motorists in recognizing appropriate driver actions.

When conducting nighttime work and work on high-speed roads, the guidelines need to follow the normal highway work zone traffic control, as provided in the MUTCD. It does not matter how short the duration of the work is, all of the guidelines in the MUTCD should be followed.

There is a much higher risk associated with nighttime work and work on high-speed roadways to attempt to customize traffic control treatments only for utility work zones.

Different types of temporary traffic control devices, which have safety benefits may be considered in the proposed guidelines. For example, it may be recommended that the taller grabber cones be used in utility work zones instead of the short cones. They are more visible to the driver of a passing vehicle. When recommending a specific type of device, the importance of this, as it relates to safety, will be provided. Once the guidelines are developed, a transition phase is necessary to allow the utility companies and contractors to have the appropriate equipment and devices to conform to the guidelines. This transition phase should take into consideration the cost of the devices and allow the companies to begin slowly purchasing the needed traffic control devices each year in order to follow the temporary traffic control guidelines.

An assessment of the risk associated with working in different locations, as compared to the roadway, is very important. Also, the amount of risk, as compared to the characteristics of the roadway, is also important. The amount of risk and hazard present in a work zone will be considered in the development of the guidelines.

3.2 Training Program Needs Assessment

The training program that will be developed will be based on the needs of the audience. A training program for utility workers will need to be different from a training program for individuals in management positions and policy makers. It is expected that two different training programs may need to be developed for utility work zone traffic control.

In order to develop the training programs, techniques for retaining and retrieving knowledge will be identified in order to determine the proper curriculum for the training programs. In the book entitled The Long-Term Retention of Knowledge and Skill: A Cognitive and Instructional Perspective by Marshall J. Farr, several published literatures related to the topic of long-term retention of knowledge and skills are reviewed. The following factors were found to influence long-term knowledge retention [16, 17, 18, 19]:

- Degree of Original Learning
- Content/Task Characteristics
- Retention Interval
- Instructional Strategies/Conditions of Learning
- Conditions of Retrieval
- Differences in Retention Capabilities of Individuals

The following paragraphs briefly describe the noted factors that will be considered when developing the training programs.

Degree of Original Learning

Farr's review of several research studies concluded that, "the single most important determinant of both knowledge and skill retention is the amount of degree of original learning". Thus, it can be deduced that one way to reduce memory loss is to strengthen or increase the degree of original learning. Most of the studies indicate that this may be achieved by providing extra practice or trials, or by incorporating 'over learning' techniques into the original learning process [16, 17].

Content/Task Characteristics

The type of task included in the learning process and its complexity determines the ease with which it can be acquired, and the degree to which it can be retained. For example, continuous control tasks or motor skills are better retained than discrete procedural tasks, which are verbally mediated or executed. The complexity of a task, including organization and integration are predominant factors for retention and acquisition [16].

Retention Interval

The time between the initial learning and retrieval period determines the degree of knowledge retention. The longer the period of non-use, the greater the decay of knowledge. The decay also depends upon the complexity, instructional strategy and nature of task [16, 17].

Instructional Strategies/Conditions of Learning

The methodology adopted to teach the knowledge or skill, plays a significant role in determining how well the learner acquires the knowledge and how long he/she can retain it. Instruction

should enable the student not only to recognize the topics learned, but also to apply them in the proper context. Thus, instruction should be designed to give the student the ability to perform the correct task in a required situation.

When the conditions of learning are varied, it becomes more difficult for the learner to acquire the knowledge/skill, but eventually results in better learning and retention. This can be attributed to the fact that under varied learning conditions, learners have multiple retrieval cues and thus, the information and tasks are better ingrained in memory [16, 18, 19].

Conditions of Retrieval

The situation under which retention is measured, influences the degree of retention. If the environment in which knowledge/skills to be recalled resembles the environment in which the knowledge/skills were originally learned, better retention will be achieved [16].

Differences in Retention Capabilities of Individuals

The ability of a person to retain knowledge/skills is dependent on his/her unique characteristics. The characteristic of an individual that impacts long-term retention includes his/her ability, prior knowledge and motivation. These issues and others must be considered in developing the training program.

An evaluation of the retention and skills of different audiences will be studied further in the training program development process. This will help in determining in what manner each training program should be taught, and how often the training should be repeated in the future. The following paragraphs describe some of the differences that need to exist between the training program for utility workers and the training program for management and policy makers.

Training Program for Utility Workers

The utility worker training should focus on the safety of their lives and the protection of the passing vehicles and their occupants traveling through the utility work zones. Utility workers need a training program that is short and interesting to retain their attention. Although workers may participate in a training program once a year, if they are not interested in what is being

taught, they may not retain information from the training program. In order to keep the utility workers interested, the training program should be interactive and provide information that workers will be able to relate to and not soon forgot. The only way to reduce the number of crashes and injuries in utility work zones is by having workers take the appropriate safety measures that are taught in these training programs and apply them in the field in their every day work routine.

The utility worker training program should be accessible to the workers, whether it is available through their supervisors and/or available online. The training should also be continuous so that the knowledge the workers gain will continue to increase. The more an issue is stressed to the workers, the more likely they will remember it. The knowledge that these workers will receive through the training programs should help them improve their safety performance and use of temporary traffic control devices in the work site.

Training Program for Management and Safety Officials

The training program for management and safety officials should be different from the training program for utility workers. This training program should focus on the value of utility work zone safety. It should contain information about how they can minimize the risk of crashes in utility work zones and provide information where they can receive utility work zone guidelines and safety training materials in order to supply them to others in their company. They need to learn about what should be done and what should not be done. By teaching management and safety officials this information, they can in turn teach what they have learned to others.

4.0 CONCLUSIONS

Developing utility work zone guidelines and training programs requires the consideration of many issues related to location, mobility, motorist and pedestrian safety, and worker health and safety. Through the State-of-the-Art Synthesis, State-of-the-Practice Synthesis, and the on-site investigations of utility work zones and utility workers, gaps in existing guidelines and training were identified. After identifying the gaps, a needs assessment of the guidelines and training were conducted as a part of this study. It was found that every utility company and contractor uses different guidelines for their temporary traffic control, and most do not follow exactly what

is needed. For those that do follow the standards, there are still hazards that exist in the work zone that workers may or may not be aware of. The following describe the conclusions for the guidelines gap and needs assessment:

1. *Guideline Uniformity* – There is limited uniformity between the guidelines that various utility companies and contractors use. Every state, county, city, utility company and contractor has different guidelines, or a variation of the guidelines, that they follow. The utility work zone guidelines developed as a part of this project should be followed by everyone involved in utility work zone-related work and should not vary between states, cities, and counties. Every utility worker needs to know what the guidelines are, and what is always expected of their temporary traffic control, regardless of the jurisdiction.

2. *Crash and Injury Risk-Based Work Zone Categories* – There are currently no categories for utility work zones based on the magnitude of potential risk associated with the location of work. These categories need to be developed as a part of this study, and may include differentiating utility work zone traffic control treatments for various functional classifications of roads:
   - Freeways
   - Major Arterials
   - High Speed Rural Roads
   - Local/Residential Roads

3. *Standardized Plans* – There are currently no standardized plans for utility work zone guidelines. Standardized plans should be provided so that utility workers have more specific guidelines to follow. There should be standards for the traffic control set-up and the devices that should be used in utility work zone traffic control. The types of traffic control devices that are very common in utility work zones, including warning lights and cones, should be standardized.

4. *Recommended Devices* – The current guidelines do not include recommendations as to what specific traffic control device should be used at the utility work zone. The proposed guidelines need to include suggestions for characteristics of the traffic control devices; thus, uniformity can be achieved. The recommended devices will be such that they are easily seen and understood by the motorist. A transition period should be provided so that the utility companies and contractors have enough time to purchase the devices to conform to the guidelines.

Most utility companies and contractors say that a training program is required once a year; however, some of their utility workers do not remember the last time they took part in a training program. Even if they do have a training program once a year, it seems that the utility workers do not recognize the importance of the training, and may not be interested in it. The following represents conclusions for the training programs:

1. There needs to be two separate training programs, one for the utility workers and one for management and policy makers. The material that should be taught and the way in which it is presented will vary between these two programs, based on their roles within their companies/agencies.

2. The training program for the utility workers should be short, should retain the attention of the workers, should be easily accessible, and should provide continuous learning for the utility workers.

3. The training program for management and policy makers should focus on the value of utility work zone safety. The importance of utility work zone guidelines in minimizing crash risks should be stressed. The program should also be easily accessible and those attending the program should be able to have access to additional information on utility work zone guidelines and training.

This gap study and assessment of the needs for the utility work zone guidelines and training will be used in future activities of the project. The next task will be to develop utility work zone safety guidelines from the observations of the existing literature, current practices, and on-site investigations.

5.0 REFERENCES

1. Fatality Analysis Reporting System (FARS) Web-Based Encyclopedia, U.S. Department of Transportation National Center for Statistics and Analysis. http://www-fars.nhtsa.dot.gov/.

2. Ullman, G. L., and T. A. Scriba. Revisiting the Influence of Crash Report Forms on Work Zone Crash Data. In *Transportation Research Record 1897*, TRB, National Research Council, Washington, D.C., 2004, pp. 180-182.

3. Manual on Uniform Traffic Control Devices for Street and Highways. U.S. Department of Transportation, Federal Highway Administration, 2003 Edition, 2004.

4. *Development of Standard and Procedures for Temporary Traffic Control at Utility Work Zones*. Wayne State University Transportation Research Group, August 2006.

5. Ullman, B. R., M. D. Finley and N. D. Trout. *Identification of Hazards Associated with Mobile and Short Duration Work Zones*. Texas Transportation Institute Report No. 4174-1, September, 2003. http://tti.tamu.edu/documents/0-4174-1.pdf.

6. Washington State Department of Transportation, *Work Zone Traffic Control Guidelines*, M54-44, January 2006, http://www.wsdot.wa.gov/publications/manuals/fulltext/M54-44/Workzone.pdf.

7. Tsygamov, A., R. Machemehl, K Liapi and N Mohan. *Traffic Control Improvements for Urban Arterial Work Zones: A Summary*. Center for Transportation Research, University of Texas at Austin.

8. Hawkins, Jr., H. G. and K. C. Kacir. Traffic Control Guidelines for Urban Arterial Work Zones, In *Transportation Research Record 1281*, TRB, National Research Council, Washington, D.C., 1990, pp. 127-135.

9. Bryden, J. *Traffic Control Handbook for Mobile Operations at Night Guidelines for Construction, Maintenance and Utility Operations*, U.S. Department of Transportation, Federal Highway Administration, Report FHWA-SA-03-026, August, 2003. http://www.dot.state.il.us/brl/1023.pdf.

10. Ullman, Gerald L. Special Flashing Warning Lights for Construction, Maintenance, and Service Vehicles. In *Transportation Research Record 1715*, TRB, National Research Council, Washington, D.C., 2000, pp. 43-50.

11. Kamyab, A., and T. McDonald. *Synthesis of Best Practice for Increasing Protection and Visibility of Highway Maintenance Vehicles-Final Report*, Iowa DOT Project TR-475, CTRE Project 02-107, Sponsored by Iowa Department of Transportation and Iowa Highway Research Board, August 2002.

12. Knapp, B. G. and R. F. Pain. Human Factors Considerations in Arrow-Board Design and Operation. In *Transportation Research Record 703*, TRB, Washington D. C., 1979, pp. 1-8.

13. Griffith, A. S. and M. Lynde. Evaluation of Arrow Panels for Temporary Work Zones. Oregon Department of Transportation Report No. FHWA-OR-RD-02-02, August 2001.

14. Turner, J. D., C. J. Simmons and J. R. Graham. High Visibility Clothing for Daytime Use in Work Zone. In *Transportation Research Record 1585*, TRB, National Research Council, Washington, D.C., 1997, pp. 1-8.

15. Arditi, D., M. Ayrancioglu and J. Shi, *Worker Safety Issues in Night-Time Highway Construction*, Engineering, Construction, and Architectural Management Journal, Vol. 12, Issue 5, pgs. 487-501, Emerald Group Publishing Limited, 2005.

16. Farr, M.J., The Long-Term Retention of Knowledge and Skills, A Cognitive and Instructional Perspective, Recent Research in Psychology, Springer-Verlag, New York, 1987.

17. Kamuche, F. U., and R. E. Ledman, "Relationship of Time and Learning Retention". Morehouse College, 2003. http://abe.villanova.edu/proc2003/kamuche.pdf.

18. Lammlein, S. E., and C. C. Cochran, "Development of the LTM: A Training Design Tool". Personnel Decisions Research Institutes, Inc., 1996. www.ijoa.org/imta96/paper62.html.

19. Naidr, J. P., T. A. Adla, A. Janda, et al. (2004), "Long-Term Retention of Knowledge After a Distance Course in Medical Informatics at Charles University Prague". Lawrence Erlbaum Associates, Inc. www.leaonline.com/doi/pdf/10.1207/s15328015tlm1603_6?cookieset=1.

APPENDIX I – CURRENT PRACTICES SURVEY

QUESTIONNAIRE SURVEY OF CURRENT UTILITY WORK ZONE PRACTICES OF CONTRACTORS AND UTILITY COMPANIES

The objective of this survey is to collect detailed information on agency standards, policies, and local guidelines for UTILITY WORK ZONE safety and traffic control. Collectively, these survey results will be used to determine the state of the practice in utility work zone traffic control. They will also be utilized in developing utility work zone safety and mobility guidelines for FHWA. Your response and input in this guideline development process is very important, and your cooperation is greatly appreciated. You may type directly onto this survey form and return it via mail, e-mail, or fax to the contact listed at the end of the form and return the survey as soon as possible.

1. Has your company established standards for traffic control in utility work zones?

☐Yes ☐No

If Yes, please send a copy of the standards/guidelines to the address listed at the end of this survey, or if it is available online please provide the website where it can be obtained on the following line:

_____

2. Does your company follow the Manual of Uniform Traffic Control Devices (MUTCD)?

☐Yes ☐No

3. Does your company conduct periodic process reviews of its utility work zone programs?

☐Yes ☐No

If Yes, how frequently? _____

4. Has your company established specific standards/guidelines for emergency traffic control in utility work zones?

☐Yes ☐No

5. Does your company have different standards/policies for roadway work based upon work duration?

☐Yes ☐No

If Yes, please check policy-specific durations as appropriate. (Check all that apply.)

☐1 hour or less ☐1-2 hours ☐2-4 hours ☐4-8 hours ☐8 hours or more

☐Other(s): _____

6. Does your company have different standards/policies for roadway work based upon work location?

☐Yes ☐No

If Yes, please check as appropriate. (Check all that apply.)

☐On roadway ☐On shoulder ☐Above roadway ☐Outside shoulder within ROW

☐All of the above

7. Does your company have different standards/policies for roadway work based upon the type of work?

☐Yes ☐No

If Yes, check all that apply.

☐Electric ☐Gas ☐Cable ☐Phone ☐Sanitary sewer ☐Storm sewer ☐Water main

☐Traffic signals ☐Street lights ☐Other(s): _____

8. Does your company have different standards/policies for roadway work based upon roadway type?

☐Yes ☐No

If Yes, please check as appropriate.

☐Local Roads ☐Collectors ☐Arterials ☐Freeways
☐All of the above

9. Does your company coordinate its utility work zone projects with other agencies or the public?

☐Yes ☐No

If Yes, please check as appropriate.

☐State DOT ☐Local/County Highway Agency ☐Media ☐Citizens Groups
☐All of the above

10. Does your company have a standard traffic control plan for utility work zones?

☐Yes, one standard plan
☐Yes, several standard plans based on project type
☐No

11. If a worker has questions as to the appropriateness of a utility work zone traffic control plan, whom are they directed to contact? _____

12. Has your company personnel/contractors been involved in any utility work zone-related crashes, injuries, or fatalities in the past five years?

☐Yes ☐No

If Yes, please provide a contact name, phone number, and e-mail address where further details may be obtained.

_____

13. Has your company been involved in any tort liability cases in the past five years?

☐Yes ☐No

If Yes, please provide a contact name, phone number, and e-mail address where further details may be obtained.

_____

14. Has your company been subject to review and/or citation by the local Occupational Safety and Health Administration (OSHA)?

☐Yes ☐No

If Yes, please provide the most appropriate reason(s) (Check all that apply):

☐Non-conformance to MUTCD
☐Violation of OSHA safety training and education requirements
☐Violation of OSHA personal protective equipment requirements
☐Violation of OSHA general requirements
☐Other(s): _____

15. Does your company offer any training programs for utility work zone traffic control for contractors or employees?

☐Yes ☐No

If Yes, please send a copy of the training materials to the address listed at the end of this survey or if it is available online, please provide the website where it can be obtained on the following line:

_____

16. Do you require that traffic control personnel and flaggers be certified?

☐Yes ☐No

Please list any certification programs available through your company or other agencies:

_____

_____

17. What type of utility work does your company conduct? (Check all that apply.)

☐Electric ☐Gas ☐Cable ☐Phone ☐Sanitary sewer ☐Storm sewer ☐Water main
☐Traffic signals ☐Street lights ☐Other(s): _____

18. Your Name and Title: _____

Company Name: _____

Address: _____

Telephone No.: _____

Fax No.: _____

E-Mail: _____

Thank you for participating in this survey. Your help is greatly appreciated.

Please mail, e-mail, or fax your completed survey to:

Peter T. Savolainen, Ph.D.
Assistant Professor
Department of Civil and Environmental Engineering
Wayne State University-Transportation Research Group
5050 Anthony Wayne Drive, Room #2166
Detroit, MI 48202
Phone: (313) 577-3766
Fax: (313) 577-3881
E-mail: savolainen@wayne.edu

Contractors and Utility Companies Survey Results

Has your company established standards for traffic control in utility work zones?

Yes	25	93%	No	2	7%

Does your company follow the Manual on Uniform Traffic Control Devices (MUTCD)?

Yes	25	93%	No	2	7%

Does your company conduct periodic process reviews of its utility work zone programs?

Yes	22	81%	No	5	19%

Has your company established specific standards/policies based for:

Emergency traffic control in utility work zones?

Yes	17	63%	No	10	37%

Roadway work based upon work duration?

Yes	16	59%	No	11	41%

Roadway work based upon work location?

Yes	21	78%	No	6	22%

Roadway work based upon the type of work?

Yes	9	33%	No	18	67%

Roadway work based upon roadway type?

Yes	20	74%	No	7	26%

Does your company coordinate its utility work zone projects with other agencies or the public?

Yes	23	85%	No	4	15%

Does your company have a standard traffic control plan for utility work zones?

Yes	20	43%	No	27	57%

If a worker has questions as to the appropriateness of a utility work zone traffic control plan, whom are they directed to contact?

Crew Supervisor	19	70%	Safety Professional	23	85%

Have your company personnel/contractors been involved in any utility work zone-related crashes, injuries, or fatalities in the past 5 years?

Yes	12	44%	No	15	56%

Has your company been involved in any tort liability cases in the past five years?

Yes	3	11%	No	24	89%

Has your company been subject to review and/or citation by the local Occupational Safety and Health Administration (OHSA)?

Yes	11	41%	No	16	59%

Does your company offer any training programs for utility work zone traffic control for contractors or employees?

Yes	23	85%	No	4	15%

Do you require that traffic control personnel and flaggers be certified?

Yes	14	52%	No	13	48%

APPENDIX II – ON-SITE INVESTIGATIONS CHECKLIST AND RESULTS

Checklist for Utility Work Zone Site Visits

Name of Company: _____

Date: _____ Time: _____ Weather: _____

Observer Name(s): _____

Location Information

Street Name of Site: _____

City: _____ State: _____

Type of Roadway: ❒ Freeway ❒ Arterial ❒ Collector ❒ Local

Utility Work Information

Location of Work: ❒ Underground ❒ Above Ground

❒ On Roadway ❒ On Shoulder ❒ Outside Shoulder within ROW

Land Use: ❒ Residential ❒ Commercial ❒ Industrial

Type of Work:

❒ Electric ❒ Phone ❒ Sanitary Sewer ❒ Traffic Signals ❒ Water Main

❒ Gas ❒ Cable ❒ Storm Sewer ❒ Street Lights ❒ Other: _____

Expected Duration of Work: _____ Actual Duration of Work: _____

Temporary Traffic Control Information

Amount of Time for Installation: _____

Amount of Time for Removal: _____

Type of Control Used (Check all that apply and write how many):

❒ Barricades - #: ____

❒ Cones - #: ____

❒ Drums - #: ____

❒ Warning Lights on Drums - #: ____

❒ Flaggers - #: ____

❒ Flashing Lights on Trucks - #: ____

❒ Truck Mounted Attenuator- #: ____

❒ Arrow Panel - #: ____

❒ Utility Work Ahead sign - #: ____

❒ Workers Ahead sign - #: ____

❒ Shoulder Work sign - #: ____

❒ Lane Closed Ahead sign - #: ____

❒ Worker Symbol sign - #: ____

❒ Road Work Ahead sign - #: ____

❒ Flagger Symbol sign - #: ____

❒ One Lane Road Ahead sign - #: ____

❒ End Road Work sign - #: _____ ❒ Road Closed Ahead sign - #: ____

❒ Others: _____

_____

_____

Temporary Traffic Control Plans

Are temporary traffic control plans prepared ahead of time? ❒ Yes ❒ No

If no, do they have standards that they are required to follow? ❒ Yes ❒ No

Who is responsible for reviewing and/or approving the temporary traffic control?

❒ Traffic Engineer ❒ Permits Engineer ❒ Contractor ❒ Utility Company

❒ Other: _____

Additional Notes: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Note: Take pictures of temporary traffic control set-up and videotape the work zone.

Summary of On-Site Investigations

Site No.	Location	Type of Work	Type of Roadway	Land Use	Location of Work	Expected Duration	Time for Installation of TTC	Time for Removal of TTC	Temporary Traffic Control (TTC)	TTC Plans Ahead of Time	Notes
1	Hartwell Road, Detroit, MI	Gas	Local	Residential	Underground within ROW	4 hours	10 min.	10 min.	14 cones (2 with DANGER Gas signs), 1 Utility Work Ahead sign with 2 flags	No	
2	Norfolk Road, Dearborn Heights, MI	Gas	Local	Residential	Underground within ROW	8 hours	10 min.	10 min.	15 cones (8 with flags, 3 with DANGER GAS signs), 1 Utility Work Ahead sign with 2 flags, 1 half of Type I barricade	No	
3	Birch Road and Michigan, Dearborn, MI	Gas	Local	Commercial	Underground within ROW	8 or more hours	< 5min	< 5 min	14 cones (2 with DANGER GAS signs), 1 Utility Work Ahead sign with 2 flags, 2 half of Type I barricades	No	
4	Chapel Road, Brightmore, MI	Gas	Local	Residential	Underground within ROW	1 hour	< 5min.	< 5 min.	2 cones, 2 half of Type I barricades, Flashing Lights on Truck	No	
5	Ford Rd, Dearborn Heights, MI	Gas	Arterial	Commercial	Underground within ROW	4 hours	5 min,	5 min.	7 cones, 1 Utility Work Ahead sign, 1 Construction Ahead sign, Flashing Lights on truck	Yes	One worker not wearing safety vest
6	Warren Ave, Detroit, MI	Gas	Arterial	Commercial	Underground within ROW	more than 1 day	30 min.	30 min,	74 cones, 14 half of Type I Barricades, 1 Type II Barricade, 1 Flashing Arrow Panel, 1 Road Work Ahead sign, 1 Utility Work Ahead sign, 1 left lane ends symbol sign	No	

Summary of On-Site Investigations (Cont.)

Site No.	Location	Type of Work	Type of Roadway	Land Use	Location of Work	Expected Duration	Time for Installation of TTC	Time for Removal of TTC	Temporary Traffic Control	TTC Plans Ahead of Time	Notes
7	John R., Detroit, MI	Gas	Arterial	Commercial	Underground within ROW	more than 1 day	30 min.	30 min.	51 cones, 1 Type I Barricade, 1 Utility Work Ahead sign, 1 Shoulder Closed sign, 1 worker digging symbol sign, 1 Road Construction Ahead sign, 1 Men Working sign, 1 Flashing Arrow Panel	No	
8	Euclid, Detroit, MI	Gas	Local	Residential	Underground within ROW	more than 1 day (possibly one month)	½ day	½ day	9 Drums (8 with lights), 2 Concrete Barricades, 1 Road Work Ahead sign, 1 Sidewalk Closed sign	No	State Barricade set-up TTC
9	Cass Avenue, Detroit, MI	Sewer	Collector	Commercial	Underground in Roadway	2 hours	< 5 min.	< 5 min.	3 cones, Flashing Lights on Truck, 1 Barrier for manhole	No	Workers were not wearing safety vests
10	Southfield Road, Lincoln Park, MI	Water Main	Arterial	Commercial	Underground in Roadway	6 hours	15 min.	15 min.	29 cones, 1 Utility Work Ahead sign with 2 flags, 1 Flashing Arrow Panel, Oscillating Lights on 2 trucks, 2 Barriers for manholes	No	Workers were not wearing safety vests
11	River Bank, Lincoln Park, MI	Gas	Local	Residential	Underground within ROW	1 hour	10 min.	10 min.	18 cones, 2 Construction Ahead signs	No	

Summary of On-Site Investigations (Cont.)

Site No.	Location	Type of Work	Type of Roadway	Land Use	Location of Work	Expected Duration	Time for Installation of TTC	Time for Removal of TTC	Temporary Traffic Control	TTC Plans Ahead of Time	Notes
12	College Road, Allen Park, MI	Gas	Local	Residential	Underground within ROW	2 hours	10 min.	10 min.	10 cones, 1 Utility Work Ahead sign, Flashing lights on machine	No	
13	Dequindre Road, Detroit, MI	Gas	Collector	Residential	Underground within ROW	1 hour	10 min.	10 min.	13 cones, 2 Utility Work Ahead signs, Flashing lights on one of the four vehicles		
14	Allen Road and King Road, Woodhaven, MI	Traffic Signals	Arterial	Commercial	Above Ground in Roadway	30 minutes	1 min.	1 min.	Flashing Lights and Arrows on Trucks		Trucks were Orange
15	Allen Road and Carter Boulevard, Woodhaven, MI	Traffic Signals	Arterial	Commercial	Above Ground in Roadway	20 minutes	1 min.	1 min.	Flashing Lights and Arrows on Trucks		Trucks were Orange
16	Knoxville Road, Peoria, IL	Gas	Commerci al Drive	Commercial	Underground with ROW	3 hours	10 min.	10 min.	4 cones, Flashing Lights on Trucks	No	
17	Northview Street, Peoria, IL	Gas	Local	Residential	Underground within ROW	2 hours	15 min.	15 min.	8 cones, 2 Utility Work Ahead signs	No	
18	Velde Drive, Pekin, IL	Gas	Local	Residential	Underground within ROW	8 hr/day for 1 week	20 min.	20 min.	9 cones, 1 Utility Work Ahead sign, I Worker Symbol sign	No	
19	Executive Drive, Pekin, IL	Gas	Local	Residential	Underground	5 hours	None	None	None	No	All work done on new develop-ment site with road closed

Summary of On-Site Investigations (Cont.)

Site No.	Location	Type of Work	Type of Roadway	Land Use	Location of Work	Expected Duration	Time for Installation of TTC	Time for Removal of TTC	Temporary Traffic Control	TTC Plans Ahead of Time	Notes
20	Ryan, Peoria, IL	Gas	Collector	Residential	Underground in Roadway and Shoulder	8 hr/day for 4 days	1 hour	45 min.	14 barricades, 8 cones, 1 Utility Work Ahead sign	No	
21	Spalding, Peoria, IL	Gas	Arterial	Commercial	Underground	8 hr/day for 4 days	1 hour	45 min.	12 barricades, 1 Worker Ahead sign with 2 flags	No	
22	Oak Street, Oak Hills, IL	Electric	Local	Residential	Above Ground within ROW	6 hours	10 min.	10 min.	5 cones, Flashing Lights on Truck	No	
23	Sommer Place, Peoria, IL	Gas	Local	Residential	Underground within ROW	8 hr/day for 1 week	20 min.	20 min.	2 Utility Work Ahead signs	No	
24	Renesellor, Livonia, MI	Gas	Local	Residential	Underground	1.5 hours	10 min.	10 min,	3 cones, 1 Shoulder Work sign	No	Workers were not wearing vests
25	Middlebelt Road, Livonia, MI	Gas	Arterial	Residential	Underground with ROW	8 hr/day for 3 weeks	1 hour	1 hour	17 cones, 12 Drums with Lights, 4 Barricades, 2 Concrete Barriers, 1 Arrow Panel, 1 Worker Symbol sign, 1 Work Zone Begins sign, 1 Work Zone Ends sign, 1 Right Lane Closed Ahead, 1 Injure/Kill a Worker sign, 2 Road Work Ahead signs, Flashing Lights on Truck	Yes	Arrow Panel had lights not working, workers without vests
26	Dunsany Court, Northville, MI	Gas	Local	Residential	Underground	6 hours	5 min.	5 min.	5 cones, 2 half of Type I Barricades, 1 Shoulder Work sign	No	Workers not wearing vests

Summary of On-Site Investigations (Cont.)

Site No.	Location	Type of Work	Type of Roadway	Land Use	Location of Work	Expected Duration	Time for Installation of TTC	Time for Removal of TTC	Temporary Traffic Control	TTC Plans Ahead of Time	Notes
27	Eastside Drive, Plymouth, MI	Gas	Local	Residential	Underground	2 hours	< 5 min.	< 5 min.	5 cones, 1 Shoulder Work sign	No	Workers not wearing vests
28	Sandusky Street, Findlay, OH	Electric	Collector	Residential	Above Ground on Roadway and Shoulder	6 hours	10 min.	10 min.	12 cones, 2 Utility Work Ahead signs, Flashing Lights on all vehicles	No	
29	Allen Twp 218, Van Buren, OH	Electric	Arterial	Residential	Above Ground on Roadway and Shoulder	5 hours	10 min.	10 min.	12 cones, 2 Utility Work Ahead signs (one with 2 flags), Flashing Lights on all vehicles	No	

APPENDIX III – RESULTS OF UTILITY WORKER INTERVIEWS

Utility Work Zone Site Visits Questionnaire for Utility Worker Interviews

Location (Street Name): _____

Date: _____ Time: _____ Weather: _____

1. What is the predominant type of utility work performed by your company?

   ❑ Electric ❑ Phone ❑ Sanitary Sewer ❑ Traffic Signals ❑ Water Main
   ❑ Gas ❑ Cable ❑ Storm Sewer ❑ Street Lights ❑ Other: _____

2. What is the typical duration of the utility work performed?

   ❑ <30 min. ❑ 30 min-1 hr ❑ 1-2 hrs ❑ 2-4 hrs ❑ 4-8 hrs ❑ >8 hrs

3. How long does it typically take to install the temporary traffic control? _____ minutes

4. How long does it typically take to remove the temporary traffic control? _____ minutes

5. Does your company follow the Manual on Uniform Traffic Control Devices (MUTCD) for the temporary traffic control in utility work zones?

   ❑ Yes ❑ No

6. Has your company established separate standards/guidelines for temporary traffic control in utility work zones? ❑ Yes ❑ No

7. How often do you follow the standards/guidelines?

   ❑ All the time ❑ Sometimes ❑ Never

8. Do you feel that the standards/guidelines are good?

   ❑ Strongly Agree ❑ Agree ❑ Neutral ❑ Disagree ❑ Strongly Disagree

9. Are you required to take a work zone safety training program?

   ❑ Yes ❑ No

10. How many times a year do you receive work zone safety training?

    ❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5 ❑ 6 ❑ >6

11. What form is the work zone training program?

    ❑ One day course ❑ Multiple day course ❑ Online course
    ❑ Self taught material ❑ Other: _____

12. Do you feel that your safety performance is good?

    ❑ Strongly Agree ❑ Agree ❑ Neutral ❑ Disagree ❑ Strongly Disagree

13. Do you feel that you perform better due to the work zone safety training?

❑ Strongly Agree ❑ Agree ❑ Neutral ❑ Disagree ❑ Strongly Disagree

14. In what format would you like your utility work zone standards/guidelines to be?

❑ Manual ❑ Smaller Field Manual ❑ Laminated Poster ❑ Other: _____

15. Do you have access to work zone training materials?

❑ Yes ❑ No

If yes, where do you get this material from? ❑ Online ❑ Supplied by company ❑ In Mail ❑ Other: _____

Thank you for your cooperation.

Total Interviews = 64

1. What is the predominant type of utility work performed by your company?

Gas	46	71.9%
Traffic Signals	2	3.1%
Water Main	2	3.1%
Electric	14	21.9%

2. What is the typical duration of the utility work performed?

< 30 min	2	3.1%
30 min to 1 hr	4	6.2%
1 to 2 hrs	6	9.4%
2 to 4 hrs	19	29.7%
4 to 8 hrs	17	26.6%
> 8 hrs	16	25.0%

3. How long does it typically take to install the temporary traffic control?

0 to 5 min	8	12.5%
6 to 10 min	19	29.7%
11 to 15 min	14	21.9%
16 to 20 min	5	7.8%
21 to 30 min	8	12.5%
> 30 min	6	9.4%
Not Involved in TTC	4	6.2%

4. How long does it typically take to remove the temporary traffic control?

0 to 5 min	11	17.2%
6 to 10 min	18	28.1%
11 to 15 min	12	18.8%
16 to 20 min	6	9.4%
21 to 30 min	8	12.5%
> 30 min	5	7.8%
Not Involved in TTC	4	6.2%

5. Does your company follow the Manual on Uniform Traffic Control Devices (MUTCD) for the temporary traffic control in utility work zones?

Yes	56	87.5%
No	4	6.2%
Don’t Know	3	4.7%
Not Involved in TTC	1	1.6%

6. Has your company established separate standards/guidelines for temporary traffic control in utility work zones?

Yes	26	40.6%
No	37	57.8%
Not Involved in TTC	1	1.6%

7. How often do you follow the standards/guidelines?

All the time	38	59.4%
Most of the Time	24	37.5%
Never	1	1.6%
Not Involved in TTC	1	1.5%

8. Do you feel that the standards/guidelines are good?

Strongly Agree	9	14.0%
Agree	37	57.8%
Neutral	14	21.9%
Disagree	3	4.7%
Strongly Disagree	0	0.0%
Not Involved in TTC	1	1.6%

9. Are you required to take a work zone safety training program?

Yes	62	96.9%
No	2	3.1%

10. How many times a year do you receive work zone safety training?

<1	16	25.0%
1	42	65.6%
2	4	6.2%
3	1	1.6%
>6	1	1.6%

11. What form is the work zone training program?

One day course	38	59.4%
Multiple day course	4	6.3%
Online course	0	0.0%
Self taught material	2	3.1%
Other: 1 Hour to Half Day Course	20	31.2%

12. Do you feel that your safety performance is good?

Strongly Agree	25	39.1%
Agree	36	56.2%
Neutral	3	4.7%
Disagree	0	0.0%
Strongly Disagree	0	0.0%

13. Do you feel that you perform better due to the work zone safety training?

Strongly Agree	12	18.8%
Agree	35	54.7%
Neutral	11	17.2%
Disagree	4	6.2%
Strongly Disagree	2	3.1%

14. In what format would you like your utility work zone standards/guidelines to be?

Manual	3	4.7%
Smaller Field Manual	35	54.7%
Laminated Poster	24	37.5%
Other: Computer	2	3.1%

15. Do you have access to work zone training materials?

Yes	56	87.5%
No	8	12.5%

If yes, where do you get this material from?

Online	4	6.9%
Supplied by company	49	84.5%
In Mail	0	0.0%
Other: Safety Supervisor	4	6.9%
Other: Phone Number	1	1.7%