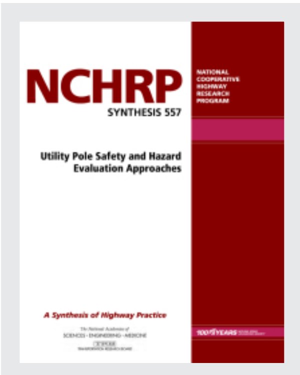


# Utility Pole Safety and Hazard Evaluation Approaches (2020)

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

**NCHRP SYNTHESIS 557**

# Utility Pole Safety and Hazard Evaluation Approaches

## *A Synthesis of Highway Practice*

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## ABOUT THE NCHRP SYNTHESIS PROGRAM

Highway administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to highway administrators and engineers. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire highway community, the American Association of State Highway and Transportation Officials—through the mechanism of the National Cooperative Highway Research Program—authorized the Transportation Research Board to undertake a continuing study. This study, NCHRP Project 20-05, "Synthesis of Information Related to Highway Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an NCHRP report series, Synthesis of Highway Practice.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

## FOREWORD

By Tanya M. Zwahlen
Staff Officer
Transportation Research Board

The objective of this *NCHRP Synthesis 557* is to summarize the strategies, policies, and technologies that state transportation agencies (STAs) and utility companies use to address potential utility pole hazards. The report documents how STAs and utility companies identify, evaluate, and successfully address these concerns.

The state of practices was examined through a review of literature, an online survey of state transportation agencies, and interviews with state transportation agencies, which led to the creation of case examples highlighting successful strategies, policies, and technologies that address potential utility pole hazards.

Charlie Zegeer collected and synthesized the information and wrote the report. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation.

# CONTENTS

Note: Photographs, figures, and tables in this report may have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org) retains the color versions.

SUMMARY

# Utility Pole Safety and Hazard Evaluation Approaches

## Background

Crashes and related deaths and injuries involving utility poles have been a problem in the United States for many decades. Recently, more than 900 people died annually, and approximately 40,000 more were injured each year in collisions with utility and light poles along streets and highways. Utility poles are second only to trees as the most commonly struck fixed object in fatal crashes on the nation's highways in recent years (NHTSA 2018).

Historical estimates document more than 100 million rigid utility poles within U.S. highway rights-of-way, with an estimated 75,000 utility pole collisions each year. These numbers correspond to nearly 4 million utility pole collisions over the past 50 years—and currently about nine collisions per hour, or one vehicle striking a utility pole every 7 minutes (Ivey and Scott 2017). In terms of fatalities, over the 50 years between 1965 and 2015, approximately 63,000 people died as a result of utility pole collisions in the United States (NHTSA 2018).

Highway engineers have recognized the unforgiving nature of utility poles and other rigid fixed objects since the 1960s. In the intervening years, the design of roadsides has changed dramatically. Breakaway ground-mounted signs and luminaire supports, crash cushions, traversable clear zones, crashworthy guardrails and bridge rails, and safer drainage structures are just some of the changes that have likely saved tens of thousands of lives. Some state transportation agencies (STAs) also have made improvements to utility pole-placement policies, and efforts are routinely undertaken to situate new utility poles as close to the right-of-way line as possible, per federal guidelines. Many utility poles in high-risk locations before 1967 have since been removed, relocated to safer locations, or otherwise improved in terms of safety (Ivey and Scott 2004).

STAs and local public agencies (LPAs) are major stakeholders in addressing this safety problem. In cooperation with affected utility owners (UOs), they may take the lead in developing safety programs designed to identify poles in high-risk locations, prioritize them for mitigation, and coordinate with UOs to tackle the problem through measures such as pole relocation, pole removal, pole shielding, conversion to less rigid (i.e., breakaway) poles, and/or delineation. UOs can also take the lead in reducing the risks of pole collisions because they are in a position to make positive decisions that will serve the needs of their managers, employees, stockholders, and the public for many years to come. A few STAs, LPAs, and UOs have implemented these basic steps while others are still being encouraged to initiate this process.

Table 1 briefly overviews some of the key studies relevant to utility pole safety between 1965 and now. Despite these activities, utility pole fatalities continue at the rate of approximately 900 each year, in addition to the thousands of nonfatal injuries annually from collisions with utility poles.

**Table 1. Examples of key studies on utility pole safety since the 1960s.**

| Year | Agency | Author | Title |
|---|---|---|---|
| 1967 | AASHTO | Yellow Book | Design and Operational Practices Related to Highway Safety |
| 1973 | FHWA | Wentworth | Motor Vehicle Accidents Involving Utility Poles—Summary of Data Availability |
| 1974 | AASHTO | Yellow Book | Design and Operational Practices Related to Highway Safety |
| 1980 | FHWA | Mak and Mason | Accident Analysis—Breakaway and Nonbreakaway Poles, Including Sign and Light Standards Along Highways |
| 1980 | NCHRP | Michie and Mak | Interim Criteria for Identifying Timber Utility Poles for Breakaway Modification |
| 1983 | TRB | Zegeer and Parker | Cost-Effectiveness of Countermeasures for Utility Pole Accidents |
| 1986 | FHWA | Ivey and Morgan | Timber Pole Safety by Design |
| 1987 | AA&P | Good, Fox, and Joubert | An In-Depth Study of Accidents Involving Collisions with Utility Poles |
| 1989 | TRB | Ivey and Mak | Recommended Guidelines for New Utility Installations |
| 1991 | NHUC | Ivey | The Time Has Come for Utility Pole Safety Programs |
| 1992 | FHWA | Buser and Buser | The Breakaway Timber Utility Pole: A Survivable Alternative |
| 1993 | NCHRP | Ross et al. | Recommended Procedures for the Safety Performance Evaluation of Highway Features |
| 1993 | TRB | Ivey, Branstad, and Griffin | Guardrail End Treatments in the 1990s |
| 1995 | FHWA | Hehr | The First Installation of Breakaway Timber Utility Poles |
| 2011b | AASHTO | AASHTO | Roadside Design Guide (RDG) |
| 2001 | TRB | Scott and Ivey | Utility Poles and Roadside Safety—The Road to Responsibility |
| 2004 | NCHRP | Lacy et al. | Report 500, Volume 8 |
| 2004 | TRB | Ivey and Scott | Utilities and Roadside Safety, TRB State of the Art Report 9 |
| 2007 | New Jersey Department of Transportation (DOT) | Gabler, Gabauer, and Riddell | Breakaway Utility Poles: Feasibility of Energy-Absorbing Utility Pole Installations in New Jersey |
| 2009 | AASHTO | AASHTO | Manual for Assessing Safety Hardware (MASH), First Edition |

FHWA Federal Highway Administration
NCHRP National Cooperative Highway Research Program
TRB Transportation Research Board
AA&P Accident Analysis and Prevention
NHUC National Highway Users Conference

## Purpose of Report

The purpose of this synthesis report is to summarize the strategies, policies, and technologies that STAs and UOs use to respond to safety concerns associated with utility poles. Information was gathered from a comprehensive literature review and also from the results of STA and UO surveys and interviews. Specific areas of interest for this synthesis report include methods employed to identify problem poles at high-risk locations, pole-placement policies, strategies and countermeasures applied to reduce the risk of pole-related collisions and resulting injuries and deaths, and funding sources for implementing countermeasures. Case studies were developed for exemplary STAs and UOs, highlighting some of their utility pole safety activities.

## STA Survey Results

Of the 50 STAs surveyed for this study, 92% (46 of 50) responded or were able to participate. Valuable information was shared regarding the current state of safety practices for utility poles. Safety programs, guidelines, and countermeasures in use by STAs to improve utility pole safety were identified.

### Utility Pole-Placement Guidelines

Utility pole-placement guidelines typically follow those established in the AASHTO Green Book, *A Policy on Geometric Design of Highways and Streets* (AASHTO 2011a), and the AASHTO *Roadside Design Guide* (AASHTO 2011b), which focus on placing utility poles as close to the right-of-way line—and as far from the roadway—as possible. A few states provide additional guidance, such as minimum pole offset distances from the road in urban areas (e.g., 5 feet from the road) and in rural areas (e.g., 10 feet from the road). In some states, the guidance is to avoid placing poles in high-risk areas, such as close to the road on the outside of horizontal curves, at the top of a T-intersection, at a lane drop, or in a median or traffic island. Appendix A includes a list of web-based guidelines for utility pole placement in each of the 50 states.

#### *Exceptions to Placement Guidelines*

Some STAs provide written criteria detailing when exceptions to the current guidelines are permitted. For example, exceptions are often approved during the design phase of a new road or when a road is widened or reconstructed. Exceptions to STA pole-placement guidelines are usually granted when pole relocation is impractical or too costly or when it would cause an "extreme hardship" to the UO. Other STAs allow exceptions when the right-of-way is inadequate and/or the topography (e.g., a steep slope or a jog in the right-of-way line) does not allow an adequate right-of-way. A few other STAs said that exceptions are simply not granted for any reason. Most of the STAs were not aware of local agencies or UOs that had their own pole-placement guidelines that differed from the STA guidelines.

### Utility Pole Crashes

In terms of reporting on utility pole crashes, all but 7 of the 46 STAs responding to the survey identified a separate code for "utility pole" crash involvement on the state's crash report form. However, reporting thresholds vary from state to state. While all states generally require the submission of crash reports to the state department of motor vehicles (DMV) or a related agency, if an injury or fatality occurs, the criteria for reporting property damage only (PDO) crashes vary widely and usually range from approximately $200 to $1,000. Thus, total utility pole crash numbers are not reported consistently from state to state. Of the 887 fatal utility pole (plus luminaire) crashes that reportedly occurred in the United States in 2017, more than half were in the 10 states that have the most utility pole fatal crashes (Florida, Texas, California, Pennsylvania, Tennessee, North Carolina, Illinois, New York, Georgia, and Indiana). Of course, these 10 states are also among the states with the largest populations and the highest total miles driven.

### *Tracking High-Risk Poles*

In terms of STA procedures for tracking high-crash and high-risk pole locations, only 4 of the 46 state respondents to the survey routinely identify poles or locations that have experienced utility pole crashes to support conducting follow-up inspections. However, a total of 14 states reportedly have a process in place to identify utility poles in high-risk locations (e.g., too close to the road, on the outside of horizontal curves, at intersections or lane drops) for potential treatment, regardless of prior crash experience.

### *Safety Measures*

The traffic engineering or safety engineering office of an STA typically holds responsibility for the selection and implementation of safety measures to address locations where utility pole crashes occur. The countermeasures most often cited as options for treating utility pole safety problems include guardrails, crash-attenuation barrels, shoulder widening or paving, rumble strips, pole-visibility features, steel-reinforced safety poles (i.e., breakaway poles), underground utility lines, and shared utility agreements. The New Jersey DOT mentioned that it uses fiberglass poles in certain situations because they shatter on impact from a motor vehicle, lowering the chance of a severe injury to vehicle occupants (compared to the risks associated with steel and wooden poles).

## Funding Options

Improvements for utility pole safety can be funded by various federal, state, local, and other financing sources. Most of the STAs confirmed the use of federal funds, with many specifically indicating the receipt of Highway Safety Improvement Program (HSIP) funding (FHWA 2016). About half of the STAs verified state funding as part of their safety improvement funding. Such financing sources included Strategic Highway Safety Program (SHSP), matching, state maintenance, spot safety improvement, and state safety funds. Nine STAs noted the use of local funds as a partial match for certain projects. Results from the STA survey are listed in Appendix B.

## Factors Related to Utility Pole Crashes

Researchers have conducted numerous studies since the 1970s on utility pole crash factors and potential countermeasures, as illustrated in Table 1. Characteristics of roadways and poles that are related to greater frequency of utility pole crashes include higher volume of vehicular traffic, or average annual daily traffic (AADT); larger number of poles per mile within the highway right-of-way; closer pole offset (i.e., narrower distance between the pole and the roadway); greater roadway curvature (i.e., sharper horizontal curves, steeper vertical grades, or both); lower pavement skid resistance; and lack of proper curve superelevation (Zegeer and Parker 1983).

Research indicates that approximately 5% of utility pole crashes lead to injuries for at least one person, and between 1% and 2% of such crashes result in a fatality. A greater chance of death or serious injury from a utility pole collision was associated with higher impact speeds and greater pole circumference (Mak and Mason 1980). Crashes involving wooden poles (rather than metal poles) were usually more severe, likely because most metal poles analyzed in the safety research also have slip or frangible bases (Zegeer and Parker 1983). In addition, pole crashes on horizontal curves were more severe than crashes on tangents, and pole crashes on tangents were more severe than those at intersections, probably because of higher driving speeds on tangents (Fox, Good, and Joubert 1979).

### *Utility Poles at High-Risk Locations*

A utility pole in a high-risk location is defined as one that is placed in a position in the roadway environment where the pole carries an above-average risk of an errant motorist striking it and where serious injury or death is a likely outcome of such a collision. Ivey and Scott (2017) estimated that no more than 1/10 of 1% (0.001) of utility poles, or no more than 100,000 such poles, are installed nationwide. Examples of high-risk pole locations (which increase the chance of a collision) include poles close to intersections, poles on the outside of horizontal curves (and close to the road), poles immediately after (and in line with) a lane drop, poles in the roadway median or traffic islands, and poles adjacent to reverse curves (Ivey and Scott 2004). Utility poles in these types of places may be considered to be in high-risk locations and are typically identified as in need of safety measure (Ivey and Scott 2004).

### *Cost-Effectiveness of Treatments*

In their research in the 1980s, Zegeer and Parker (1983, 1984) developed a utility pole crash-prediction model based on traffic volume (AADT), pole density, and pole offset from the road. This crash-prediction model led to the further development of estimated crash effects and also crash modification factors (CMFs) for countermeasures such as moving poles further from the road (i.e., pole relocation), reducing the number of poles within a roadway section (i.e., increasing pole spacing), employing poles for multiple uses (i.e., removing a line of poles on one side of the road and doubling the number of lines on the poles on the other side), burying utility lines underground (combined with pole removal), and employing breakaway poles.

The safety effect of a given roadway treatment is usually expressed in terms of a CMF. For example, if a roadway countermeasure reduces a certain crash type (e.g., utility pole crashes) by 30%, the accident reduction factor (ARF) (i.e., the crash-reduction factor) is 30%, and the CMF is 0.70 ($1 - .30 = 0.70$). That is, if 10 crashes per year occurred at a site before the treatment, the expectation would be 7 crashes per year after the solution is implemented ($0.7 \times 10 = 7$). Based on the CMF values developed in the FHWA study by Zegeer and Parker (1983), estimated cost of pole-related crashes, and cost of countermeasures, the cost-effectiveness charts and tables in this synthesis report address several scenarios.

The factors that are most closely related to utility pole crashes include traffic volume (AADT), pole density (i.e., number of poles per mile), pole offset (distance from poles to the roadway), and type of pole (telephone, electric, one-phase or three-phase, or transmission pole). Another factor documented as important is the measure of other roadside features (termed a roadside rating) that affect the number of crashes that still occur if a pole is removed, moved, or altered.

Several conclusions were evident about generally cost-effective utility pole-related countermeasures. For example, pole relocation, buried underground utilities, multiple-use poles, and breakaway poles were cost-effective—i.e., with a benefit-cost ratio greater than 1.0—for many of the analyzed roadway situations. Cost-effective treatments often result when utility poles are initially close to the roadway and when combined traffic volume is moderate to high (e.g., AADT exceeding approximately 10,000 vehicles). Such a benefit-cost ratio (greater than 1.0) is also particularly characteristic of (1) poles that are relocated from 5 feet or less to a distance of at least 20 feet from the road and (2) a shift to underground utility lines in conjunction along a corridor, combined with pole removal for "close" poles on high-volume roads. Multiple-use poles (i.e., those that double-up lines on only one side of the road) were cost-effective for many roadway situations. The reduction of pole density alone (by simply increasing the distance between poles) rarely proved to be cost-effective under any situation because of the high cost of pole relocation and the relatively modest safety benefit from this measure (Zegeer and Parker 1983).

It is important to mention that moving poles is generally challenging and expensive. Removing or relocating a single pole from the roadside environment is not always appropriate or practical; often, an entire row of poles and lines would require repositioning to attain the safety benefits and also to transmit the utility line effectively. Countermeasures involving telephone poles are usually less costly than those for poles carrying electric lines—and therefore more likely to be cost-effective compared to similar treatments for larger electric transmission poles and lines. Breakaway devices on poles were considered to be cost-effective for individual poles in high-risk locations—although the CMFs for this treatment are still only estimates and not as well established. Because of the large size of transmission poles and the associated costs of moving them, none of the countermeasures involving moving these poles or lines was documented as cost-effective. In such instances, the use of a guardrail or crash-attenuation devices would generally be less costly and much more likely to be cost-effective compared to trying to move these poles (Zegeer and Parker 1983).

To put the previous cost-effectiveness discussion in context, it should be cautioned that the cost of crashes and the price of countermeasures have both increased since the referenced Zegeer and Parker (1983) study was conducted. Therefore, to compute more up-to-date benefit-cost ratios for various utility pole treatments, the same previously described CMF values could be used, but with more updated costs for countermeasures and crashes for a given roadway situation.

For example, researchers would need to obtain newer solution costs from the utility company that owns and maintains the utility poles that would be affected by a proposed safety improvement. In addition, current crash costs are available from FHWA for use in a benefit-cost analysis. Specifically, economic analysis of a given countermeasure, such as a treatment involving utility poles, requires data on the cost of a traffic crash at various severity levels (PDO, injury, and fatality). Harmon, Bahar, and Gross (2018) provided such updated information.

A benefit-cost analysis also incorporates input on the interest rate, effectiveness of the solution (i.e., the CMF), and cost of the treatment. The price associated with a specific countermeasure (e.g., pole relocations) should be obtained from the relevant STA or UO, based on previous costs for similar projects under local conditions.

## STA and UO Utility Pole Treatment Options

In addition to actions entailing changes to poles, as previously discussed, a wide range of other treatment options are available to STAs to reduce the incidence of vehicles leaving the roadway and to lessen the severity of any resulting crash. Such countermeasures include crash cushions (e.g., sand inertia barrels), portable concrete barriers, breakaway structures, composite breakaway (e.g., fiberglass) poles, steel-reinforced safety poles (breakaway poles), low-profile barriers, guardrails and extruder terminals, breakaway guy wires, delineations on the roadway or on the poles, and buried duct networks for utility cables. Of course, other measures also are available to aid in keeping vehicles on the roadway, such as in-advance curve warning signs or chevrons, edge-line rumble strips, superelevations on horizontal curves, and many other design options. Any of these solutions can be considered to reduce the frequency and severity of utility pole crashes under various conditions (Ivey and Scott 2004).

### *Example of a Logical Approach to Utility Pole Safety Program*

In TRB's State of the Art Report 9, Ivey and Scott (2004) describe a three-path plan for reducing utility pole fatalities. This plan, as developed and described by Ivey and Scott (2004), explains the following approach options:

- **Best Offense**. This approach identifies sites that are overrepresented in number of collisions, considers available countermeasures, prioritizes sites for treatment, and implements the improvements.
- **Best Bet**. This approach prioritizes identifying potentially hazardous poles and roadway sections, possibly using statistical prediction algorithms, before a crash history develops and also executing appropriate improvements.
- **Best Defense**. This approach is put into practice by striving to meet recommendations in the AASHTO *Roadside Design Guide* (2011b) and in TRB's State of the Art Report 9 (Ivey and Scott 2004).

### *Examples of Utility Pole Safety Initiatives*

Based on information in the literature and survey responses, several STAs and UOs were selected for development of more detailed case studies. The STAs included Washington State, New Jersey, Georgia, and North Carolina. One anonymous STA was discussed in a case example because its utility pole safety program was scaled back in recent years in response to challenges that the STA faced in dealing with UOs within the state. The synthesis report includes this case example with the thought that other STAs might relate to similar challenges and develop their own tailored approaches to address them. To protect privacy, four unnamed UOs were selected for documentation of their utility pole safety practices and policies.

## Research Needs

Based on gaps in knowledge about utility pole safety, several research needs were identified. The report recommends specific research such as the following to fill those gaps:

1. Conduct a study to update the countermeasure-related costs and current CMFs for utility pole treatments that UOs can implement, such as running utilities underground, relocating poles, employing multiple-use poles, and reducing pole density.
2. Evaluate steel-reinforced safety (breakaway), fiberglass, and other yielding poles. Also evaluate the use of various types of barriers, barrier end treatments, and similar devices and determine their feasibility and effectiveness when used to treat high-risk poles that cannot easily be repositioned or removed. Document how the new MASH criteria have affected the use of various roadside safety devices.
3. Perform a study of the safety problems and potential countermeasures for box-span poles (i.e., poles placed at each corner of an intersection "box" that can carry various utilities, signs, and signals), buddy poles (i.e., two poles situated next to each other, potentially causing a more severe crash if struck), and other obstacles in high-risk roadside locations.
4. Study the factors and conditions that led some STAs and UOs to place a higher priority on utility pole safety. Determine the measures that might be effective in convincing other agencies to more aggressively implement utility pole safety strategies and policies.

Analyze how dedicated funding could be made available to STAs, LPAs, and UOs for instituting safety improvements related to roadside and utility pole safety.

5. Develop model policies for STAs and UOs that go beyond the guidance in the AASHTO Green Book (AASHTO 2011a) and the *Roadside Design Guide* (AASHTO 2011b) and are suited to the specific safety needs of each jurisdiction.
6. Define and document the range of methods that safety officials can employ to track utility pole crashes within an STA and an LPA. In addition, document methods for the identification of high-risk poles, which should produce recommendations for improvement. Document current case studies in use by the STAs.

CHAPTER 1

# Introduction

This synthesis is based in part on *TRB State of the Art Report 9* (Ivey and Scott 2004). This report also takes advantage of decades of research regarding utility pole safety, particularly the FHWA report by Zegeer and Parker (1983), which focused on the cost-effectiveness of countermeasures for utility pole crashes. This synthesis report also summarizes the survey results from 46 responding STAs.

## The Utility Pole Problem

A collision between a vehicle and a utility pole often has a very serious outcome (Figure 1). The Insurance Institute for Highway Safety (IIHS) (2018) analyzed data from the National Highway Traffic Safety Administration (NHTSA) Fatality Analysis Reporting System (FARS), initiated in 1980 (NHTSA 1980), and concluded that in 2017, the latest year for which data are available, the nation recorded 37,133 total highway fatalities, and 7,833 of these deaths were related to fixed-object crashes. A total of 914 crashes involved utility poles. IIHS (2018) based these figures on fatal crashes when the most harmful event coded was a crash with a fixed object, regardless of whether the first harmful event also was designated as a crash with a fixed object or instead represented another type of crash, such as a collision between two motor vehicles that in turn led to a crash into a fixed object (NHTSA 2018).

In 2000, utility poles ranked fourth among the causes of all fixed-object fatalities, but by 2005, utility poles had jumped to second place, where they remained in 2017 (Table 2). Although STAs have made roadside improvements, the fatalities associated with all fixed objects remained relatively stable or even increased for some years. In 2017, utility pole fatalities accounted for approximately 12% of fixed-object deaths (Figure 2), with the number of fatalities consistently remaining between 900 and 1,020 per year for the past 10 years (2008–2017), as shown in Figure 3.

State and local transportation agencies are responsible for maintaining the highway rights-of-way under their jurisdiction and for preserving the operational safety, integrity, and function of the highway facility. This responsibility generally entails developing or adopting clear zone policies as well as working with UOs to ensure that the roadways and roadsides are reasonably safe for everyday travel.

FHWA is also a stakeholder on matters of utility pole safety and has developed guidance to address this safety concern. Federal regulations in Section 645.209 of Title 23 of the Code of Federal Regulations (23 CFR 645.209) read as follows:

> When the transportation department determines that existing utility facilities are likely to be associated with injury or accident to the highway user, as indicated by accident history or safety studies, the transportation department shall initiate or cause to be initiated in consultation with the affected utilities, corrective measures

*Figure 1. Collisions with utility poles, often with resulting serious injuries or fatalities for vehicle occupants (Image: Delaware DOT).*

**Table 2. Fixed-object fatalities 2013–2017, by type of object struck (IIHS 2018).**

| Object Struck | 2013 | 2014 | 2015 | 2016 | 2017 | Total | Percent of Total Fixed-Object Crashes |
|---|---|---|---|---|---|---|---|
| Tree | 3,604 | 3,514 | 3,611 | 3,801 | 3,691 | 18,221 | 47.74% |
| **Utility Pole** | **913** | **953** | **926** | **897** | **914** | **4,603** | **12.06%** |
| Traffic Barrier | 610 | 609 | 657 | 653 | 688 | 3,217 | 8.43% |
| Embankment | 397 | 401 | 377 | 412 | 358 | 1,945 | 5.10% |
| Ditch | 257 | 252 | 268 | 275 | 277 | 1,329 | 3.48% |
| Culvert | 237 | 218 | 239 | 256 | 244 | 1,194 | 3.13% |
| Bridge Pier | 140 | 160 | 134 | 176 | 139 | 749 | 1.96% |
| Fence | 178 | 156 | 174 | 162 | 176 | 846 | 2.22% |
| Building | 155 | 141 | 135 | 146 | 175 | 752 | 1.97% |
| Traffic Sign Support | 111 | 129 | 117 | 144 | 130 | 631 | 1.65% |
| Wall | 136 | 137 | 121 | 117 | 153 | 664 | 1.74% |
| Guardrail End | — | 110 | 99 | 118 | 113 | 440 | 1.15% |
| Other | 501 | 728 | 769 | 807 | 775 | 3,580 | 9.37% |
| **Total** | **7,239** | **7,508** | **7,627** | **7,964** | **7,833** | **38,171** | **100.00%** |

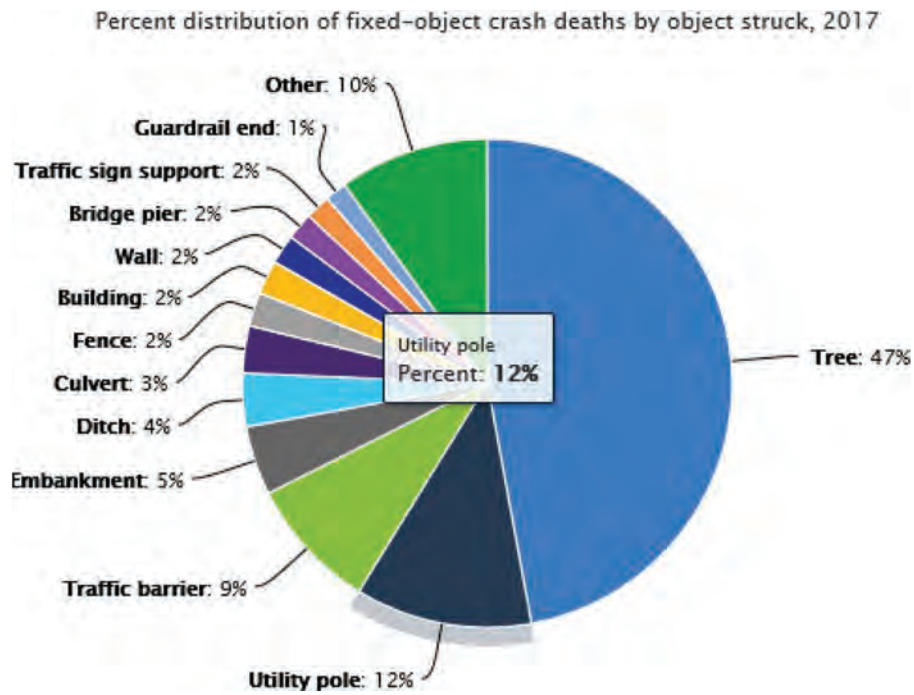



***Figure 2. Fixed-object fatalities, by type of object struck, 2017 (IIHS 2018).***

to provide for a safer traffic environment. The corrective measures may include changes to utility or highway facilities and should be prioritized to maximum safety benefits in the most cost-effective manner. The scheduling of utility safety improvements should take into consideration planned utility replacement or upgrading schedules, accident potential, and the availability of resources. It is expected that the requirements of this paragraph will result in an orderly and positive process to address the identified utility hazard problems in a timely and reasonable manner with due regard to the effect of the corrective measures on both the utility consumer and the road user (CFR 2011).

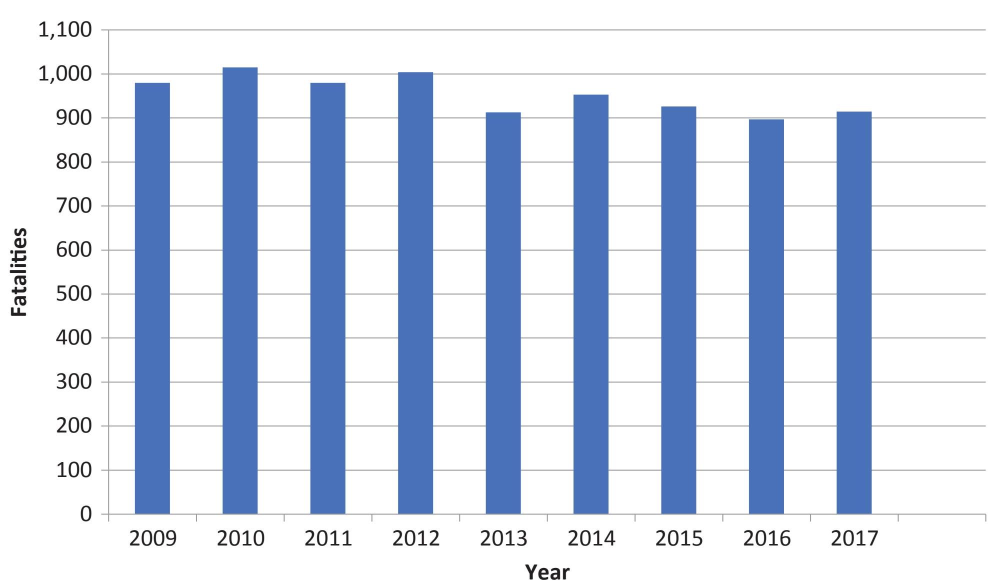



***Figure 3. Utility pole fatalities 2009–2017, by year (NHTSA 2018).***

## Report Objective

The objective of this synthesis report is to summarize the strategies, policies, and technologies that STAs and UOs employ to address these safety concerns. Information gathered for this synthesis included how STAs and UOs identify, analyze, and successfully address potential utility pole hazards. The synthesis report encompasses the following information:

- Strategies used by STAs and UOs to identify poles in high-risk locations and areas with poles that may need corrective actions
- Methods to improve roadside safety by addressing utility location
- A review of policies regarding utility placement and accommodation
- Countermeasures employed by STAs to mitigate safety problems at identified high-risk locations, including underground utility cable runs, mechanisms for pole placement and relocation on STA rights-of-way, STA evaluations, and resolution approaches for utility facilities posing hazards
- Strategies for data collection (e.g., crashes, pole location, CMFs) for pre- and post-evaluation of utility pole siting
- Existing and emerging technologies and materials (e.g., energy-dissipating, redirective, and yielding pole devices) to reduce crash severity and/or frequency
- Impediments to responding to potential utility pole hazards
- Dedicated or available funding sources for addressing potential utility pole hazards, such as federal, state, local, or private funding
- Successful programs implemented by STAs and UOs.

## Agency Surveys

The survey sent to STAs represented a major source of information for this synthesis report regarding how such agencies identify and solve utility pole safety problems. For example, STAs hold responsibility for maintaining roadways and roadside conditions, which impact the likelihood of a vehicle leaving the roadway and potentially striking a utility pole. STAs are also accountable for working with utility companies and executing written agreements with those companies about the placement of utilities within the highway rights-of-way.

UOs not only install and maintain utility poles located in state-owned rights-of-way but also repair poles damaged by vehicle strikes, weather, and other events. UOs must coordinate these efforts while maintaining electric and communication services for their customers. A separate survey, created specifically for this investigation, was distributed to major UOs in an attempt to gain insights into some of their activities to improve utility pole safety. Initial surveys were sent to selected UOs, and contacts were initiated with a few that reported ongoing utility pole safety activities and were willing to provide input for this report.

Interactions with STAs and UOs also led to the development of nine case studies (five from STAs and four from UOs) that represent some of the most comprehensive practices and projects on utility pole safety that are currently underway in the United States. These case studies are described in Chapter 9 (STA Case Examples) and Chapter 10 (Utility Owner Case Examples).

## Literature Review

To supplement the practitioner surveys and follow-up phone and email exchanges, a detailed review was conducted of the published and unpublished articles, reports, and other documentation related to utility pole safety. Guidelines on the placement and handling of utility poles in the highway rights-of-way also are evaluated in the review. This part of the synthesis report literature review focuses on issues such as the following:

- Policy details regarding the distance of poles from the road and other pole-placement criteria or regulatory guidance
- Specific roadway treatments that STAs routinely employ to reduce utility pole crashes (or decrease the risk of such crashes)
- CMFs that STAs apply when determining the costs and benefits of various strategies
- Utility company policies and practices for selecting sites where poles will be installed
- New or innovative technologies and strategies used by STAs and UOs for decreasing the risk of crash frequency, the severity of crashes involving utility poles, or both
- Details on various types of utility pole crash countermeasures.

The synthesis report's detailed literature review also emphasized finding literature on strategies in use by STAs and UOs and on data collection practices and safety impacts (i.e., CMFs) of various pole safety strategies. The review and compilation of these information sources contributed to the development of this synthesis report. The report discusses the results of past research, agency practices and policies, and utility pole safety program activities.

The rest of this synthesis report is organized as follows:

- Chapter 2: Historical Perspective
- Chapter 3: Summary of STA Survey Responses
- Chapter 4: Factors Associated with Utility Pole Crashes
- Chapter 5: Identification of Utility Poles in High-Risk Locations
- Chapter 6: Countermeasure Cost-Effectiveness
- Chapter 7: Current Countermeasure Practices
- Chapter 8: Safety Devices
- Chapter 9: STA Case Examples
- Chapter 10: Utility Owner Case Examples
- Chapter 11: Conclusions
- References and Bibliography
- Glossary
- Abbreviations
- Appendices:
  - Appendix A: State DOT Utility-Related Websites, 2019
  - Appendix B: Summary of Survey Results
  - Appendix C: Countermeasure Cost-Effectiveness Summary
  - Appendix D: FHWA Program Guide: Utility Relocation and Accommodation on Federal-Aid Highway Projects
  - Appendix E: Utility Pole and Tree Safety Case Studies
  - Appendix F: Example of Recommended Crash Reduction Program and Roadside Safety Treatments
  - Appendix G: Examples of STA Guidelines with Safety Implications

CHAPTER 2

# Historical Perspective

## Statement of the Problem

The unforgiving nature of utility poles has been recognized since the 1960s. This knowledge is as old as highway engineers' recognition of the need for forgiving roadsides, a concept that found widespread understanding and acceptance some time before AASHTO published the revolutionary *Design and Operational Practices Related to Highway Safety*, known as the Yellow Book (AASHTO 1967). In their study, Graf, Boos, and Wentworth (1976) estimated that collisions with utility poles accounted for more than 5% of nationwide crashes, more than 5% of total nationwide traffic fatalities, and more than 15% of the deaths associated with fixed-object collisions.

During the intervening years, the design of roadsides has changed dramatically. Breakaway ground-mounted sign and luminaire supports, crash cushions, traversable clear zones, crashworthy guardrails and bridge rails, and safer drainage structures are just some of the changes that likely have saved tens of thousands of lives. Some STAs have improved their utility pole-placement policies, and designers and crews routinely strive to place new utility poles as close as practical to the right-of-way line, per federal guidelines. Many utility poles in high-risk locations before 1967 have been removed, relocated, or improved somehow to enhance safety.

According to Ivey and Scott (2017), estimates suggested that as few as 100,000 poles (out of the 100 million poles in the nation's highway rights-of-way) are in high-risk areas—only 1/10 of 1% (0.001) of existing poles, a mere fraction of the total number of roadside utility poles throughout the country. Nonetheless, this low percentage of poles was cited as still posing serious roadside hazards to passing motorists on the nation's highways. Figure 4 shows an example of a utility pole located in a high-risk area (in this case, a rigid pole that is close to the road at a driveway where vehicles turn both right and left into and out of the driveway). Ivey and Scott (2017) made the point that addressing only a small fraction of all existing utility poles along roadways would have a disproportionately positive effect on roadside safety.

Highway engineers have consistently advocated the maintenance of a clear zone or a clear recovery area along roadsides; statistically, that solution should minimize or eliminate the danger for 80% of the vehicles leaving the roadway (AASHTO 1967). Furthermore, transportation engineers have consistently tried to eliminate rigid objects within the clear recovery area, and many promote the practice of removing rigid poles.

## AASHTO Design Guidelines

National AASHTO guidelines have helped guide STAs in recent years on roadway and roadside design, including the placement and treatment of utility poles. Such publications include *A Policy on Geometric Design of Highways and Streets* (6th Edition) (AASHTO 2011a), sometimes called

***Figure 4. Utility poles located close to roadway (Photo: Kevin Zegeer).***

the Green Book, and the *Roadside Design Guide* (AASHTO 2011b). The Green Book specifies that utility lines should be placed as close as practical to the highway right-of-way line. Such installations should also preserve space for potential future road improvements and utility operations and should be designed to enable utility line servicing that causes minimal traffic interference. Utility lines should also fit within the clear roadside policies that are appropriate for a given highway type or functional class. Utilities on rural or urban freeways should conform to AASHTO's *A Policy on the Accommodation of Utilities within Freeway Right-of-Way* (AASHTO 2005b). For highways and streets with noncontrolled access, applicable guidelines come from AASHTO's *A Guide for Accommodating Utilities within Highway Right-of-Way* (AASHTO 2005a).

For rural roadways, the Green Book (AASHTO 2011a) specifies that poles should not normally be situated in the median of divided highways. Furthermore, rigid objects such as utility poles (and other constructions that may be struck by vehicles that run off the road) should not be located in a highway clear zone. The Green Book refers to the *Roadside Design Guide* (AASHTO 2011b) when discussing the width of clear zones for freeways, rural arterial streets, and high-speed collector streets. For low-speed rural collector roadways and rural collector roadways—except for roads with average daily traffic (ADT) of 400 or fewer vehicles—the minimum desirable clear zone width is 7 to 10 feet.

Several statements in the Green Book consider the placement of utility poles on urban streets. For example, on curbed urban streets, utilities should be situated in the border area between the sidewalk and the curb, at least 1.5 feet from the face of curb. Furthermore, wherever practical, the utilities should be located behind the sidewalk, further from the road. For roads with shoulders instead of curbs, a clear zone should be implemented, without rigid poles.

The *Roadside Design Guide* (AASHTO 2011b) stated that the most desirable solutions for utility poles involve placing them where they are least likely to be struck or instead burying the utility lines. The use of breakaway designs was also suggested as a successfully crash-tested alternative. STAs and UOs should make every effort to install utility poles as far from the road as feasible during new construction and major reconstruction. The recommendation for agencies was to identify sites that exhibit a high concentration of utility pole crashes and then to implement appropriate improvements.

Wherever practical, utility poles should not be installed in ditches, near the turning radii of intersecting roads, or on the outside of horizontal curves. If a series of utility poles are the closest objects to the roadway, delineation of each pole is highly recommended.

The *Roadside Design Guide* (AASHTO 2011b) describes urban roadside locations. The most critical urban roads in need of possible improvement are characterized as those with a history of roadside crashes, often with other specific hazardous roadway and roadside features. Severe roadside crashes are most likely when vehicles are operating at higher speeds. The guide observes that the 1.5-foot minimum distance from the road is not intended to represent a clear recovery area, noting that vehicles can easily jump a curb and strike a pole installed at that distance. The recommendation is that the road designer apply wider lateral offset distances, whenever practical, between the roadway and rigid objects such as utility poles. During highway reconstruction, the crash history of the site should be considered when determining the appropriate roadside treatment for each roadway segment.

The recommended safety hierarchy for designing roadsides at each location specifies the following order of preference (AASHTO 2011b):

1. Remove the fixed object
2. Redesign the fixed object so that it can be safely traversed
3. Relocate the fixed object to a site where it is less likely to be struck
4. Reduce impact severity by using an appropriate breakaway device or impact attenuator
5. Redirect a vehicle by shielding the obstacle with a longitudinal traffic barrier
6. Delineate the fixed object if the previous options are not appropriate.

Many of the specific types of treatments for accomplishing each of these design goals from the *Roadside Design Guide* (AASHTO 2011b) are discussed subsequently in this synthesis report.

## Challenge of Utility Pole Crashes

The estimate is that utility poles represent more than 100 million rigid objects within highway rights-of-way (Horne 2001). Moreover, an estimated 75,000 vehicle collisions with such utility poles are reported every year (Foedinger et al. 2003). That number corresponds to more than 4 million utility pole collisions over the past 50 years—and currently about 200 collisions per day, or 9 collisions per hour, or one collision every 7 minutes (Scott and Ivey 2015).

One factor that perhaps might be influencing the response by some agencies to address the utility pole crash problem is the downturn in annual utility pole fatalities from almost 2,000 in 1975 to roughly 900 to 1,000 in recent years. Researchers generally acknowledge that the reduction in fatalities (per 100 million vehicle miles) is primarily the result of a transition from at-grade highways to the access-controlled freeways and interstate highways that dominate the bulk of highway mileage today. Other factors (such as a higher percentage of seat belt use, safer cars, stricter penalties for drunk driving) are also contributing to this downturn in utility pole fatalities in recent years.

Figure 5 depicts the cumulative number of fatalities from 1965 through 2015, with an estimate of at least 63,000 fatalities due to utility pole collisions over those 50 years. The more than 900 people killed annually because of collisions with utility poles is more than double the 408 deaths in 221 fatal crashes in the United States in 2016 resulting from all airline crashes combined (NTSB 2018). Some researchers have stated that most STAs and UOs do not give adequate attention to the utility pole safety problem. If the more recent ratio of 30,000 injuries per 1,000 fatalities holds, this would equate to more than roughly 2 million injuries between 1965 and 2015.

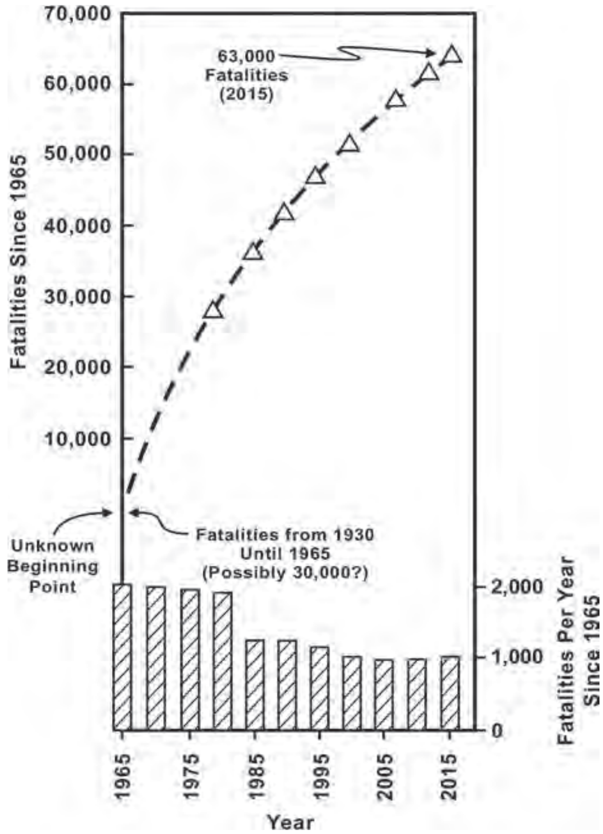



***Figure 5. Total fatalities due to utility pole collisions since 1965 (Ivey and Scott 2017).***

The rate of utility pole fatalities has not seen dramatic reductions in the past decade. If the rate of fatalities is allowed to continue at close to 1,000 per year for the next 10 years, the total number of fatalities due to collisions with utility poles since the advent of the automobile will approach an estimated 100,000. The next section reviews previous research regarding factors that influence utility pole crash frequency and severity, summarizes the crash treatments and the development of expected crash effects (the CMFs), and addresses articles and reports that suggest methods for implementing a comprehensive program to address the utility pole safety problem (Ivey and Scott 2017).

CHAPTER 3

# Summary of STA Survey Responses

A total of 46 STAs responded to the utility pole survey distributed for this synthesis report, a 92% response rate. The survey was designed to document three different categories of interest related to utility pole safety: (1) utility pole policy or placement guidelines as well as factors that may be considered in granting siting exceptions to utility poles that are inconsistent with the placement guidelines, (2) number of fatal and nonfatal collisions with utility poles, and (3) types of crash-related countermeasures that STAs consider as options for improving the safety of poles or pole locations that experience crashes or pose a high risk of collision.

Officials in the utility accommodation section, crash analysis section, and/or safety engineering section of each STA responded to the survey. The project team found that a single STA official rarely could answer all three types of questions—or even attempt to respond to the wide range of questions. Therefore, respondents sometimes gathered input from other professionals in the STA. If responses were incomplete, the project team followed up with officials in other STA offices. Appendix A provides a table of state utility accommodation guidelines.

One or more of the following methods was used to obtain survey responses:

- Survey Monkey online questionnaire
- Email correspondence
- Telephone contact
- Combination of email and telephone contacts.

Appendix B also supplies further details on the development of the survey and on individual survey responses.

## Utility Pole-Placement Guidelines

The responses received from STAs regarding utility pole-placement guidelines are summarized in Appendix B. Chapter 9 of this synthesis report is devoted to analyzing several states that enforce detailed pole-placement guidelines focused on avoiding the placement of poles in high-risk areas and thus reducing the incidence of utility pole crashes. Some of the STAs highlighted in this discussion are in Washington State, Georgia, New Jersey, North Carolina, and an anonymous state.

Another survey question asked whether the standards for utility pole placement apply equally to new poles and existing poles—and, if not, requested an explanation of the differences. In total, 18 STAs answered Yes to this question; 2 STAs responded No; and 26 STAs either did not know or did not reply to the question.

According to the 46 STA survey respondents, 15 states follow the *Roadside Design Guide* clear zone recommendations (AASHTO 2011b). Several states impose pole offset guidelines of 30 feet, with a program in place to review and correct pole siting in areas with high numbers of utility pole crashes. Four UOs were also interviewed, and some expressed interest in adopting a program to identify and modify sites that experience, or are at risk of, pole crashes.

## Exceptions to Placement Guidelines

Responses to this question about exceptions to STA pole-placement guidelines fell into two primary conceptual approaches. First, some answers addressed the STA processes governing how the exception process would function. Several agencies reported that pole-placement exceptions were determined during the design process and before granting permission to UOs to install a line of poles. The most typical responses revolved around the definition of situations that would generally justify strong consideration for approval of deviations from basic pole-placement guidelines. Second, other responses cited the specific conditions that would warrant an exception for the placement of one or more poles (representing a deviation from standards of practice).

Some of the most common answers explained that exceptions often were approved if pole removal would be too costly or would impose an extreme hardship. Respondents also cited another common exception justification: the right-of-way was inadequate, or the topography would not allow the UO to adhere to the guidelines (e.g., because of steep slopes or a jog in the right-of-way line). One respondent noted that an exception would likely be granted if it "does not cause a safety concern, and is in the best interest for the utility owner and the State DOT." At least one STA stated that it would not allow poles to be placed within the clear zone in any situations.

Several STAs observed that exceptions are determined "on a case-by-case basis," and some reported that the states might require poles to be repositioned outside of the highway right-of-way if they were too close to the road. Another STA remarked that "exceptions are rarely made, because all pole placements need to meet AASHTO clear zone requirements." Appendix B contains details on all of these responses.

## Utility Pole Crashes

This question asked STAs how many fatal and nonfatal utility pole crashes occurred in the state in 2016. This year was selected with the expectation that complete data sets would be available to all STAs. A total of 39 STAs indicated that "utility pole" is a separate item on their crash report form; 7 STAs responded that it is not.

Responses to this survey question on the number of fatal and nonfatal utility pole crashes are grouped into the following categories:

- No response given (4 STAs)
- "I don't know" (16 STAs)
- Combined number of "utility pole plus light pole" crashes because of a combined checkbox on the state crash report form (4 STAs)
- Utility pole crash numbers that seem reasonable (19 STAs).

Although 23 STAs were able to provide statistics on either crashes involving utility poles or combined crash figures for utility poles and light poles, the information was not easily acquired. Most of these STAs either (1) conducted separate data analyses to obtain these numbers for the survey or (2) de facto relied on the project team to identify the right person in the STA who could supply this information. In short, only a few of the STA safety engineers or traffic engineers had easy and direct access to these statewide numbers on utility pole crashes.

For the states that did provide the number of fatal and nonfatal utility pole crashes, the project team could not obtain a comparable number on nonfatal utility pole crashes from every state because (1) not all states include utility poles as a separate code on their crash report forms and (2) criteria for reporting crashes differ from one state to another. Some STAs (e.g., in Florida) require reports with full crash information only if one or more people were injured or killed, but most states impose various dollar-level damage criteria for reporting, ranging from approximately $200 to $1,000 for an individual crash.

Furthermore, very few of the 46 STA officials responding to the survey knew offhand how many utility pole crashes occurred in their state in 2016 without conducting a separate crash analysis. This circumstance often arose because routine crash summaries were not available by type of object struck, even for states including “utility pole” as an object-struck code on their crash report forms.

Several states conducted computer searches in response to the survey data inquiry, and they assembled numbers on fatal and nonfatal utility pole crashes in their state in 2016 (and/or for 2017). However, because of variations in crash reporting criteria and methods, these numbers for nonfatal crashes are not considered to be comparable between states. In addition to responses from STAs on this question, a summary of fatal collisions with utility poles and light poles (combined) is accessible from the FARS database, as shown in Table 3. It is interesting to note that of the 887 fatal utility (plus light) pole crashes in the United States in 2017, more than half (465 crashes) occurred in the 10 states that suffered the most fatalities: Florida (84), Texas (69), California (57), Pennsylvania (56), Tennessee (42), North Carolina (38), Illinois (36), New York (28), Georgia (28), and Indiana (27).

These numbers from the FARS database offer a more complete picture of fatal crashes because most of the responding states did not (or were unable to) supply this crash information. Note that Table 3, like its source (the FARS database), includes the number of fatal “utility plus light pole related” crashes (i.e., a combined statistic, not just fatal crashes attributable solely to utility poles) by state. FARS combines the number of fatal crashes involving utility poles and light (luminaire) poles because some state crash forms (in about 7 of the 46 STAs that responded to the survey) combine these crashes into a single code, so true utility pole crash data counts are not available uniformly throughout the nation (NHTSA 2018).

## High-Crash Location Tracking

This question asked whether STAs track locations with a history of utility pole crashes and, if so, how this is done. Of the STAs that responded to this question, only four indicated that they specifically track utility poles with a history of being struck: Pennsylvania, New York, New Jersey, and Hawaii. In addition, Alaska and Virginia confirmed that they have the potential to track utility poles with a crash history.

Two of the STAs amplified their responses. The Pennsylvania DOT observed:

> Individual utility poles are not tracked, but we do track areas with frequently struck poles. All state road locations with at least eight hit pole crashes within a 3,000-foot tolerance over the most recent 5-year time period are identified for potential safety countermeasures.

The New York DOT reported:

> Yes. The annual network screening process identifies sites where the number of utility pole crashes is higher than expected.

A few other states explained that they have computer capabilities (e.g., mapping tools, computer sorting programs) that would enable searches for utility pole sites experiencing high numbers

**Table 3. Number of STA fatal collisions involving utility poles and light poles for 2013–2017 (NHTSA 2018).**

| | 2013 | 2014 | 2015 | 2016 | 2017 | Total | Percentage |
|---|---|---|---|---|---|---|---|
| **Alabama** | 31 | 25 | 12 | 30 | 22 | 120 | 2.70% |
| **Alaska** | 2 | — | 1 | 3 | 3 | 9 | 0.20% |
| **Arizona** | 21 | 10 | 13 | 10 | 6 | 60 | 1.35% |
| **Arkansas** | 11 | 4 | 2 | 4 | 5 | 26 | 0.59% |
| **California** | 69 | 81 | 66 | 70 | 57 | 343 | 7.72% |
| **Colorado** | 3 | 4 | 10 | 1 | 2 | 20 | 0.45% |
| **Connecticut** | 14 | 19 | 14 | 13 | 14 | 74 | 1.67% |
| **Delaware** | 3 | 7 | 4 | 7 | 4 | 25 | 0.56% |
| **Florida** | 53 | 71 | 69 | 86 | 84 | 363 | 8.17% |
| **Georgia** | 30 | 25 | 32 | 31 | 28 | 146 | 3.29% |
| **Hawaii** | 8 | 4 | 4 | 7 | 2 | 25 | 0.56% |
| **Idaho** | 1 | 2 | 2 | — | 2 | 7 | 0.16% |
| **Illinois** | 27 | 37 | 28 | 28 | 36 | 156 | 3.51% |
| **Indiana** | 25 | 34 | 34 | 28 | 27 | 148 | 3.33% |
| **Iowa** | 4 | 5 | 8 | 4 | 9 | 30 | 0.68% |
| **Kansas** | 6 | 2 | 10 | 5 | 12 | 35 | 0.79% |
| **Kentucky** | 12 | 22 | 17 | 17 | 13 | 81 | 1.82% |
| **Louisiana** | 24 | 16 | 21 | 21 | 22 | 104 | 2.34% |
| **Maine** | 6 | 7 | 9 | 4 | 12 | 38 | 0.86% |
| **Maryland** | 16 | 14 | 18 | 20 | 21 | 89 | 2.00% |
| **Massachusetts** | 28 | 23 | 32 | 19 | 23 | 125 | 2.81% |
| **Michigan** | 19 | 18 | 26 | 18 | 22 | 103 | 2.32% |
| **Minnesota** | 5 | 4 | 5 | 3 | 3 | 20 | 0.45% |
| **Mississippi** | 14 | 16 | 7 | 8 | 11 | 56 | 1.26% |
| **Missouri** | 13 | 7 | 11 | 8 | 13 | 52 | 1.17% |
| **Montana** | 1 | — | 1 | 1 | 1 | 4 | 0.09% |
| **Nebraska** | 3 | 3 | 8 | 4 | 6 | 24 | 0.54% |
| **Nevada** | 9 | 6 | 7 | 2 | 2 | 26 | 0.59% |
| **New Hampshire** | 4 | 3 | 7 | 5 | 4 | 23 | 0.52% |
| **New Jersey** | 24 | 24 | 34 | 33 | 21 | 136 | 3.06% |
| **New Mexico** | 1 | 1 | 2 | 4 | 2 | 10 | 0.23% |
| **New York** | 40 | 40 | 39 | 28 | 28 | 175 | 3.94% |
| **North Carolina** | 28 | 28 | 30 | 23 | 38 | 147 | 3.31% |
| **North Dakota** | — | — | — | 1 | 0 | 1 | 0.02% |
| **Ohio** | 51 | 51 | 54 | 64 | 60 | 280 | 6.30% |
| **Oklahoma** | 8 | 8 | 13 | 11 | 6 | 46 | 1.04% |
| **Oregon** | 20 | 20 | 8 | 11 | 9 | 68 | 1.53% |
| **Pennsylvania** | 57 | 57 | 51 | 48 | 56 | 269 | 6.05% |
| **Rhode Island** | 6 | 6 | 5 | 4 | 4 | 25 | 0.56% |
| **South Carolina** | 20 | 20 | 14 | 18 | 19 | 91 | 2.05% |
| **South Dakota** | 1 | 1 | 2 | 1 | 0 | 5 | 0.11% |
| **Tennessee** | 37 | 37 | 27 | 34 | 42 | 177 | 3.98% |
| **Texas** | 78 | 78 | 74 | 88 | 69 | 387 | 8.71% |
| **Utah** | 4 | 4 | 4 | 1 | 4 | 17 | 0.38% |
| **Vermont** | 2 | 2 | 2 | 2 | 4 | 12 | 0.27% |
| **Virginia** | 14 | 14 | 22 | 11 | 19 | 80 | 1.80% |
| **Washington** | 18 | 18 | 18 | 14 | 19 | 87 | 1.96% |
| **West Virginia** | 4 | 4 | 8 | 8 | 11 | 35 | 0.79% |
| **Wisconsin** | 16 | 16 | 11 | 11 | 10 | 64 | 1.44% |
| **Wyoming** | — | — | — | — | 0 | 0 | 0.00% |
| **Total** | **891** | **898** | **896** | **872** | **887** | **4,444** | **100%** |

of utility pole crashes. However, it was not clear from their responses whether these states (e.g., Alaska, Virginia) routinely conduct searches to identify locations with abnormally high numbers of collisions with utility poles. For example, the Virginia DOT responded as follows regarding whether it tracks sites or utility poles associated with a high number of crashes:

> No, although their locations are available and can be identified quickly with the statewide crash data tool . . . [This tool] can be used to filter and search for crashes based on the data elements in our statewide crash report. The tool includes a mapping feature that returns the crash location information when a filter is run.

The Wisconsin DOT describes its process as follows:

> The WSDOT's Transportation Data, GIS & Modeling office collects, processes, analyzes and reports on all the state routes and public roads, including the history of utility poles being struck.

One state, Tennessee, responded that UOs in the state do indirectly identify poles that are struck, based on pole collision damage:

> No. Utilities (utility companies) do not track pole strikes. They do track how often a pole is replaced. Taking traffic data comparing to frequency of pole replacement is how we correlated to determine pole/traffic incidents.

Several other STAs answering this question indicated that they did not specifically track utility poles that have a history of being struck, but they offered an explanation as to how utility poles with such a history might be identified through another process. For example, several officials stated that if a site or roadway section is identified as a "black spot" (i.e., a high-crash location), then the crashes in that section of the highway are reviewed in more detail—so if numerous crashes in the high-crash site or road section involve collisions with a utility pole, then pole-related countermeasures could be considered.

## Identifying High-Risk Poles

This question asked whether STAs have a process in place to identify high-risk poles before they are struck, based on an analysis of their placement in potentially high-risk areas such as lane drops, intersections, horizontal curves, and sites too close to the road. In this survey, 14 states described such a process: Alabama, Arizona, Florida, Georgia, Hawaii, Indiana, Maryland, Massachusetts, New Jersey, Tennessee, Texas, Utah, Washington, and Wisconsin.

As shown in Figure 6, some states responded that they review the following specific utility pole-placement characteristics in the identification process:

- Within the allowable clear zone but too close to the road (11 states)
- At or near a lane drop (6 states)
- At or near an intersection (6 states)
- Outside of a horizontal curve (8 states)
- Too close to the road (11 states).

## STA Countermeasures in Use

The traffic engineering or safety engineering office of an STA typically is responsible for the selection and implementation of safety measures to address locations experiencing utility pole crashes. Of the 46 states responding to the survey, the following countermeasures are most often cited as options for treating utility pole safety problems:

- Guardrail/guiderail (31 states)
- Crash-attenuation barrels (10 states)

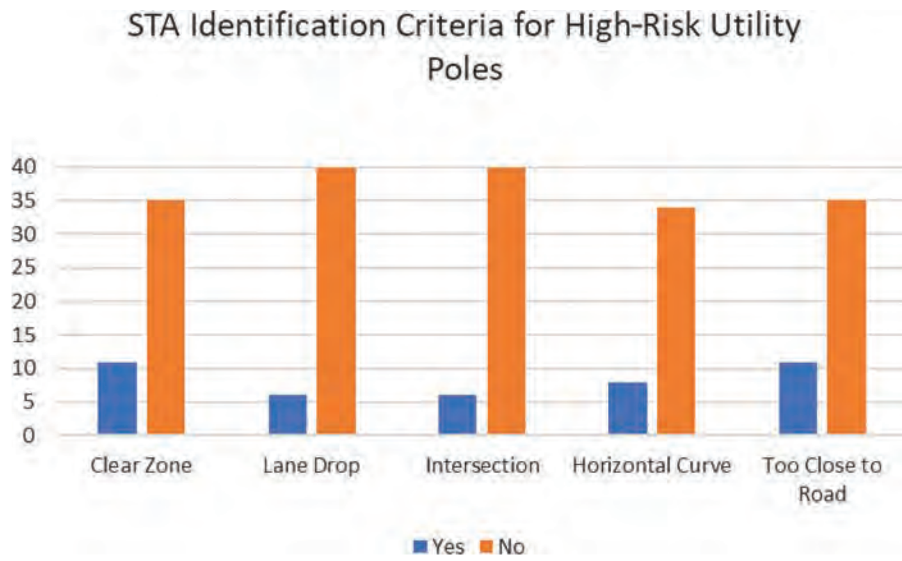



*Figure 6. Reported STA criteria for high-risk utility poles.*

- Shoulder widening/paving (15 states)
- Rumble strips (19 states)
- Pole-visibility features (25 states)
- Steel-reinforced safety poles (breakaway poles) (7 states)
- Conversion to underground utilities (23 states)
- Shared utility agreements (21 states).

The states reporting use of steel-reinforced safety (breakaway) poles are Arizona, Florida, Hawaii, Kansas, Louisiana, New Jersey, and Wyoming. New Jersey mentioned that it uses fiberglass poles in certain situations because they shatter on impact from a motor vehicle, reducing the chance of a severe injury to vehicle occupants, when compared to steel and wooden poles in the same site (Figure 7).

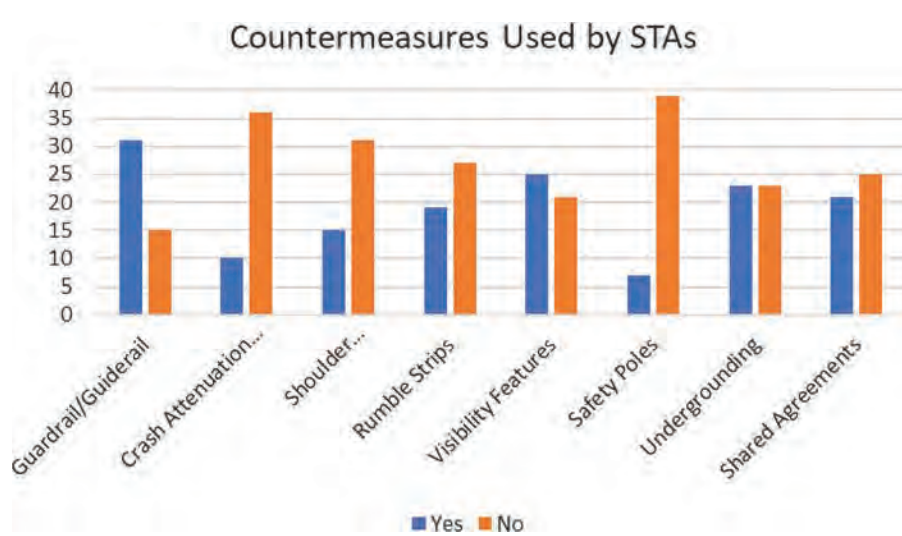



*Figure 7. Reported STA countermeasures.*

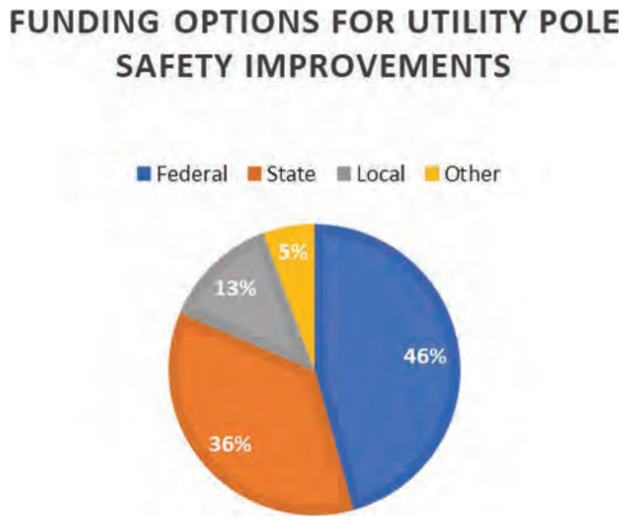



***Figure 8. Allocated and potential funding sources.***

## Funding

Improvements in utility pole safety can be financed by various federal, state, local, and other funding sources. A total of 32 STAs indicated use of federal funds, and 17 of those states specifically cited HSIP funding. There were 25 STAs that noted state funding as part of their safety improvement funding, including SHSP matching, state maintenance, spot safety improvement, and state safety funds. Nine STAs were aware of local funding sources as a partial match for certain projects. Four STAs reported using other types of funds for relocating utility poles. Figure 8 summarizes the distribution of funding sources for utility pole safety treatments by STAs.

## Local and Utility Owner Policies

Of the 46 STAs that participated in the survey, 35 answered that they knew of no local agencies or utility providers that have developed their own utility pole safety policies. Nine STAs mentioned local agencies that might have developed their own guidelines, including Phoenix, AZ; Missoula, MT; Sioux Falls, SD; Dallas and Kyle, TX; and Anchorage and Fairbanks, AK. One STA responded, "Some cities and counties have changed policies to only allow underground facilities."

Six STAs were aware of UOs that developed their own safety programs or guidelines, including the Georgia Power Company, PECO Pole Relocation Program, Eversource Electric, and Austin Energy. Several states also mentioned that the *National Electrical Safety Code* (Institute of Electrical and Electronic Engineers 2017) functioned as guidelines for the in-state utility company.

CHAPTER 4

# Factors Associated with Utility Pole Crashes

This chapter summarizes some of the most relevant studies previously conducted on utility pole safety. In particular, it addresses research that attempted to quantify the effect of various traffic and roadway features on the frequency and severity of crashes into utility poles. It also reviews research on safety appurtenances and the literature on crash prediction.

## Factors Related to Crash Frequency

Several studies attempted to analyze crash databases to identify some of the factors that drive the frequency of utility pole and other fixed-object crashes.

Wright and Mak (1976) conducted a study to determine the relationships between single-vehicle fixed-object crashes and the roadway and other variables for urban two-lane streets in Georgia. The study showed that crash rates were most highly related to traffic volume, horizontal alignment, and number of intersections per mile.

Perchonok et al. (1978) investigated the relationships between single-vehicle crashes and roadway and roadside features. Data were collected on more than 9,000 single-vehicle crashes on rural roads in six states. Horizontal alignment proved to be a major factor, with more than 40% of the crashes occurring at horizontal or vertical curves. Left curves and downgrades were overrepresented in crashes, but crashes were also overrepresented at the beginning of curves.

Cleveland and Kitamura (1978) developed a macroscopic prediction model of roadside crashes on two-lane rural roads in Michigan. During the study, they collected and analyzed data for 270 2-mile (3.2-km) roadway sections with various geometric and traffic features. They developed crash-prediction models for different traffic volume groups. The most important variables for crash prediction were restriction on passing sight distance, frequency of roadside obstacles, and length of road with roadside obstacles within various distances from the road (i.e., pole offset).

Fox, Good, and Joubert (1979) developed a crash predictive model to identify risk factors for nonintersection and intersection pole crashes. The variables resulting in the nonintersection crash model included ADT, lateral pole offset, pavement skid resistance, roadway width, horizontal curvature, pavement deficiencies, superelevation of the curve, and pole location.

Wright and Robertson (1976) conducted a study of 300 fatal fixed-object crashes on rural Georgia roads for consideration in establishing priorities for removal or modification of roadside hazards. The roadway factors most closely associated with single-vehicle crashes were curvature (greater than 6 degrees) and downhill gradient (2% or steeper) before or at the curves. A great majority of fatal crashes also occurred on the outside of the horizontal curve.

Jones and Baum (1980) reviewed more than 8,000 single-vehicle crashes from 20 urban areas in the United States, finding that the number of poles along a roadway segment (i.e., pole density or pole spacing) was the most important variable in predicting the probability of utility pole crashes. Lateral pole offset from the road represented the next most important feature, followed by road grade, road path (curvature), and speed limit.

Mak and Mason (1980) conducted a detailed study of crashes that involved utility poles, sign poles, and light poles in seven geographic areas in the United States. Pole crashes were found to be primarily an urban problem, with 85% of such crashes occurring in urban areas. The overall crash rate in terms of pole crashes per 100 million vehicle miles was 16 (i.e., 9.9 crashes per hundred million vehicle kilometers). Mak and Mason also concluded that the frequency of pole crashes was most highly associated with pole density, pole offset, and horizontal and vertical alignment.

## Factors Related to Pole Crash Severity

Several researchers studied the effects of traffic and roadway variables on the severity of utility pole crashes.

Fox, Good, and Joubert (1979) found crashes on horizontal curves to be slightly more severe than those on tangent sections because of the increased number of side impacts on curves. Utility pole crashes were more severe at nonintersections than at intersections, probably the result of lower vehicle speeds at intersections.

The Jones and Baum (1980) study indicated that 49.7% of all utility pole crashes caused personal injuries. They observed that impact speeds and pole circumference were related to the severity of utility pole crashes, but the spacing and offset of utility poles did not affect utility pole crash severity.

Mak and Mason (1980) reported a 50% chance that at least one vehicle occupant will be injured in a utility pole crash, closely matching the Jones and Baum study results. Of the 1,000 utility pole crashes included in the study, 518 (51.8%) involved one or more injuries, and 16 (1.6%) resulted in one or more fatalities. Vehicle impact speed ranked as a major factor in crash severity; other factors included utility pole type (e.g., wood, metal), presence of yielding poles, vehicle characteristics (e.g., weight, size), and impact configuration (collision location and direction of impact).

Griffin (1981) studied single-vehicle crashes in Texas, finding that 44.7% of utility pole crashes involved a personal injury. Furthermore, about 33.5% of such crashes resulted in a moderate injury (B-type injury) or worse, and 5.8% involved a serious injury (A-type injury) or a fatality. In their study of clear zones, Graham and Harwood (1982) uncovered no relationship between an agency's clear zone policy (i.e., 6:1 clear zone, 4:1 clear zone, no clear zone) and the severity of fixed-object crashes.

## Safety Appurtenances

Several previous studies addressed the issue of the effectiveness of various crash-related countermeasures, such as placing utility lines underground (and removing the poles), increasing the lateral offset of poles, installing protective barriers (e.g., guardrails), reducing the number of poles, using yielding (breakaway) poles, and employing other options. Each countermeasure is discussed below.

Most of the previous studies confirmed that burying utility lines reduces the overall severity of fixed-object crashes, based on the assumption that other less-rigid objects will be hit instead of the utility pole. The net effect is highly dependent on site-specific roadside characteristics, such as roadside slope and the number and type of other obstacles (e.g., trees, mailboxes, and other rigid objects). Some of the challenges encountered in running utility lines underground include the high installation costs and the practice of using many utility poles to also carry attached streetlamps or other related features, along with other utilities.

Hunter et al. (1978) suggested that moving poles further from the roadway will reduce fatal crashes, but that approach will not affect the overall crash frequency because vehicles will hit other obstacles after the poles are relocated.

Increasing the lateral offset of utility poles is aimed at reducing the chance of a pole being struck by an errant vehicle. Studies by Mak and Mason (1980) and by Fox, Good, and Joubert (1979) identified an overrepresentation of crashes into poles sited within 10 feet of the roadway.

In recognition of the possible increase in other fixed-object crashes as a result of pole relocation, Rinde (1979) assumed no overall reduction in the frequency of fixed-object crashes but still concluded that a drop in crash severity likely would occur.

Installing roadside hardware—such as guardrails or other impact-attenuation devices—in front of utility poles offers another technique for potentially mitigating the severity of a crash. Installing guardrails in front of poles will likely increase the frequency of fixed-object crashes because a guardrail would be a larger obstacle than the utility pole, and the guardrail must be placed closer to the roadway than the pole. *Roadside Design Guide* standards call for some separation between the guardrail and the pole (AASHTO 2011b).

Reducing utility pole density can decrease the frequency of utility pole crashes. Treatments that reduce the number of poles (i.e., pole density) include (1) shared use of multiple features on utility poles (i.e., poles that host multiple types of utilities, such as telephone lines, electric lines, and luminaries); (2) poles situated on only one side of the street instead of both sides; and (3) wider pole spacing along the roadway corridor. Jones and Baum (1980) concluded that pole density was the variable most strongly correlated with utility pole crash frequency although they did not quantify the precise impact of reducing the number of poles. One of the practical constraints when reducing the number of poles is the possible need for larger and more rigid poles to support the increased pole spacing and/or heavier utility lines. Thus, any countermeasure that decreases pole density can be costly, and the larger poles could produce an adverse effect on pole crash severity when poles are struck. The countermeasure of yielding poles is directed at reducing the severity of utility pole crashes; the expectation is that such yielding poles would not affect crash frequency. Several yielding pole designs have been developed and evaluated, such as (1) FHWA-approved (AD-IV) steel-reinforced safety poles or fiberglass yielding poles and (2) the steel slip base. Studies confirmed that yielding poles (i.e., steel-reinforced safety poles) can be effective in reducing pole crash severity.

Other countermeasures also have been employed to directly or indirectly reduce the frequency or severity of utility pole crashes. For example, Jones and Baum (1980) suggested that the use of occupant restraints (lap belts and shoulder harnesses) likely constitutes the most cost-effective countermeasure for reducing utility pole crash severity. Other proposed indirect methods for minimizing vehicle encroachments beyond the roadway include (1) improved roadway delineation, (2) warning signs in advance of high-risk locations, (3) skid-resistant pavement overlays, (4) widening of lanes and shoulders, (5) rumble strips, (6) enhanced highway lighting, and (7) improved roadway alignment through reconstruction.

## Research on Utility Pole Crash Prediction

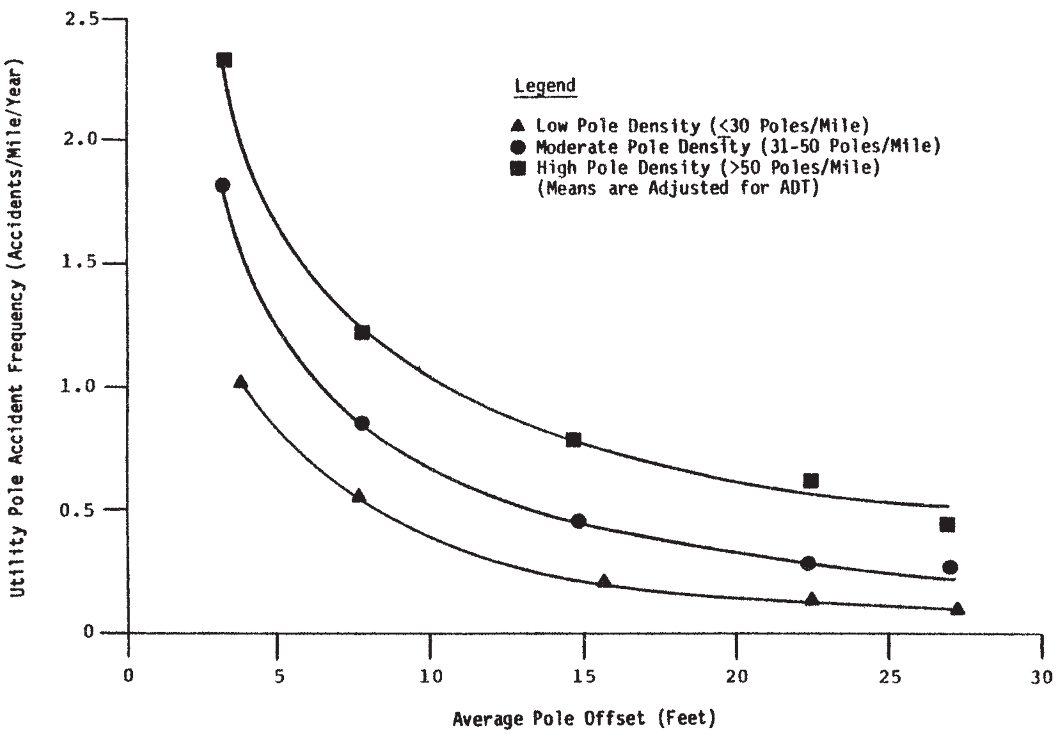
In an unprecedented study for FHWA, Zegeer and Parker (1983) sought to determine the factors associated with utility pole crashes. The first phase of the study emphasized assessing the effect of various traffic and roadway variables on the frequency and severity of utility pole crashes. Data for crash and roadway characteristics were collected for more than 1,500 roadway sections covering approximately 2,500 miles of rural and urban roads in four states: North Carolina, Washington State, Michigan, and Colorado. Roadway sections in the data sample exhibited various road widths (two-lane to six-lane), terrain conditions, and curbed and uncurbed designs. The AADTs ranged from 1,000 to about 60,000 vehicles per day, with pole densities between 10 to 90 poles per mile and pole offset distances between 2 feet and 30 feet from the roadway. Multiple area types (urban, urban fringe, and rural areas) were included as well as various roadside conditions.

The data were analyzed by using several statistical techniques (e.g., correlation, analysis of variance and covariance, and contingency-table analysis) to identify key factors associated with crashes. The following roadway features correlate most strongly with the frequency of utility pole crashes:

- AADT
- Pole offset
- Pole density.

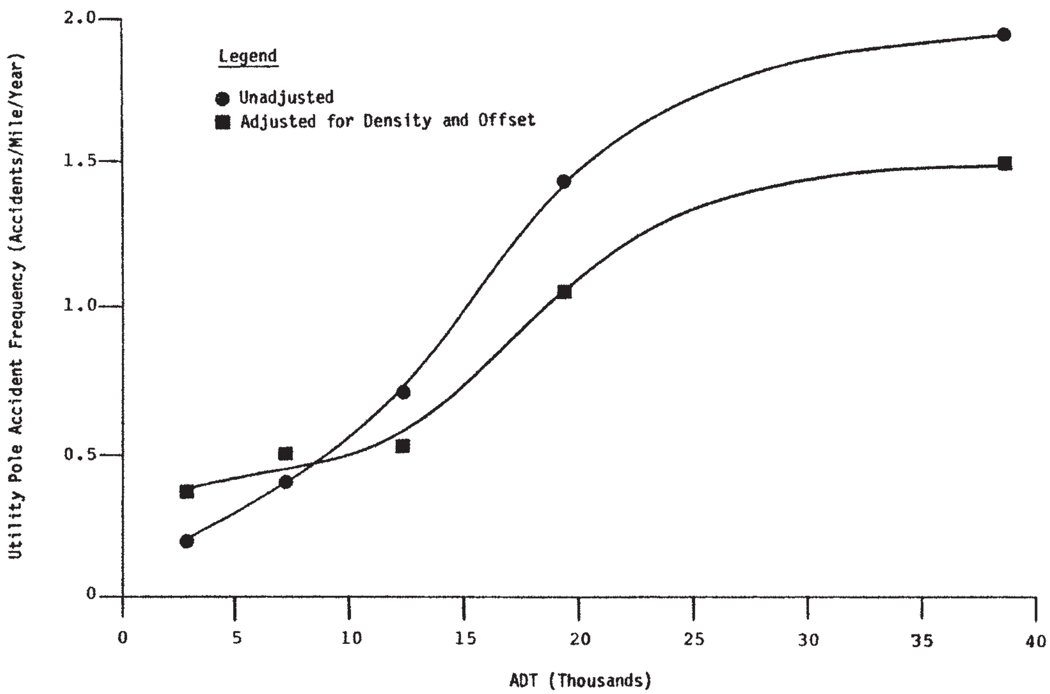
The relationship between utility pole crashes—called "accidents" in Zegeer and Parker (1983)—and the utility pole offset and pole density is illustrated in Figure 9. The relationship between traffic volume and utility pole crashes is shown in Figure 10.

In terms of crash severity when poles were within 10 feet of the roadway, wooden poles exhibited a significantly higher crash severity than metal poles. However, most of the metal poles in the study carried luminaires and featured slip or frangible bases, which are designed to break away on impact. Crash severity also rose higher on roads with greater curvature and in some speed limit categories.




Note: 1 foot = 0.3 m
1 pole/mile = 0.6 poles/km
1 accident/mile/year = 0.6 accidents/km/year

***Figure 9. Relationship between utility pole crash frequency and the pole offset and pole density.***




Note: 1 accident/mile/year = 0.6 accidents/km/year

***Figure 10. Relationship between utility pole crash frequency and traffic volume (AADT).***

Linear and nonlinear regression models were developed for utility pole crashes as a function of key roadway features. The best-fit crash-prediction model was based on the following relationship:

$$\text{Acc/Mi/Yr} = \frac{[(9.84)\times(10^{-5})\times(\text{ADT})]+[(0.0354)\times(\text{Density})]}{(\text{Offset})^{0.6}} \qquad [-0.04]$$

where

Acc/Mi/Yr = accidents (utility pole crashes) per mile per year
ADT = average daily traffic (average number of vehicles per day)
Offset = average distance from the road to the poles (in feet), for all poles in the section
Density = number of poles per mile within the section, with poles on both sides of the road counted.

The model was validated and displayed satisfactory predictive abilities, specifically an R-squared value of 0.63, a low constant (–0.04), and a low standard error (0.572). The model was verified in several ways, using sections from states that covered a wide range of traffic and roadway conditions.

A nomograph (Figure 11), developed based on the utility pole crash-prediction model, enables a simple graphical determination of the expected number of utility pole crashes for various roadway conditions. For example, the estimated number of utility pole crashes per mile per year can be determined for a roadway with an AADT of 10,000 vehicles, a density of 60 poles per mile, and an average pole offset of 5 feet: (1) enter the nomograph at the 10,000 ADT point at the bottom left; (2) proceed up to the curve labeled as 60 poles per mile and then to the right to the 5-foot offset line; and (3) go directly down to the value on the X-axis, which shows 1.15 utility pole crashes per mile per year.

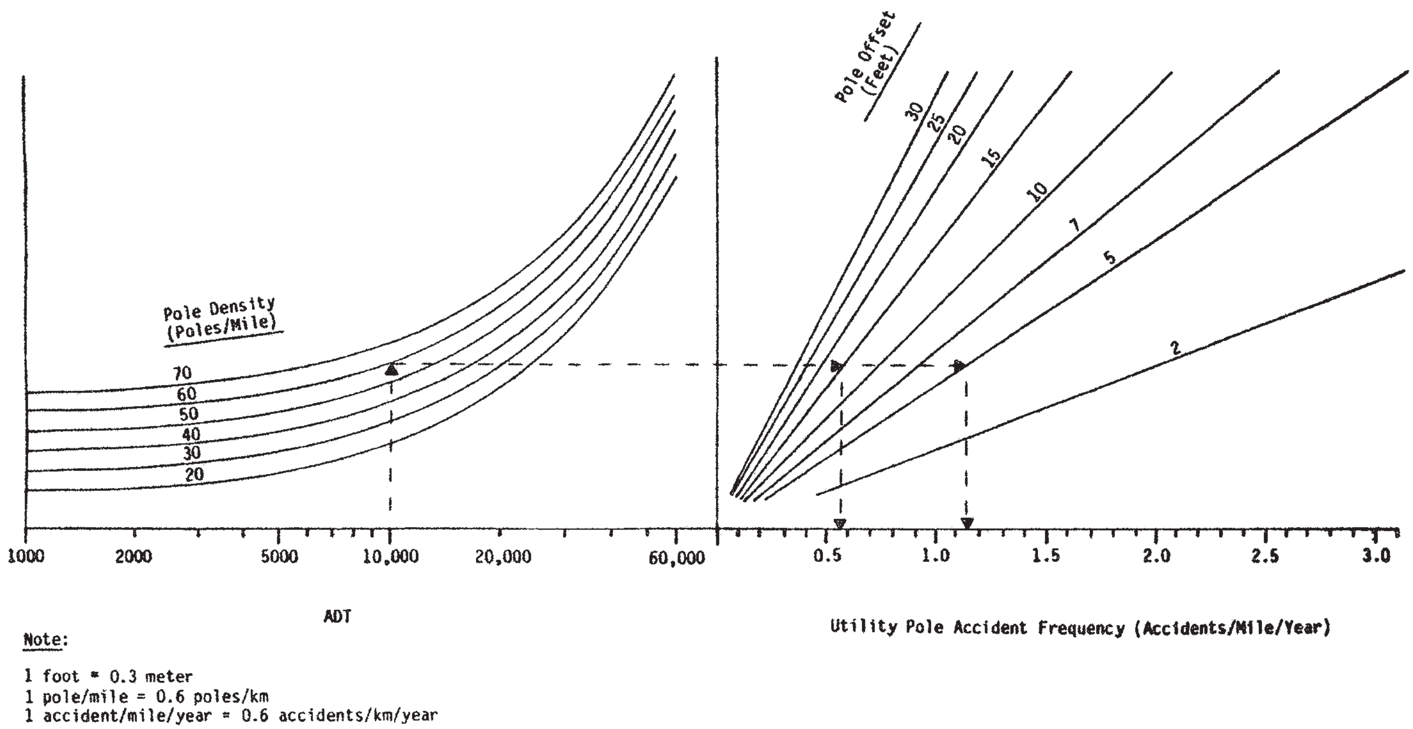



***Figure 11. Utility pole crash-prediction nomograph (Zegeer and Parker 1983).***

To illustrate the results of applying the predictive model to a countermeasure such as pole relocation, consider the values of the crash-reduction factors shown in Table 4. The first column lists the utility pole distance in the current situation; the proposed new pole offset distances are shown at the top of each of the remaining columns. To use the chart, find the current offset (first column), and move to the right along the row to locate the proposed offset column. The cell at that intersection notes the expected percent reduction in crashes. For example, if a pole is currently 5 feet from the road, moving it to 10 feet should result in approximately a 56% reduction in crashes.

By using the nomograph with various ADT, pole offset, and pole density values, the sensitivity of the model to such factors is easily seen. In the previous example, changing the pole offset from 5 feet to 15 feet, for instance, would reduce the number of crashes from about 1.15 down to 0.55, approximately a 50% reduction in predicted pole crashes. The safety effects of changing combinations of pole offset and pole density can be seen as well. This crash-prediction model was used in the Zegeer and Parker (1983) study to compute the expected crash reductions for various countermeasures related to relocating poles and/or reducing the number of poles exposed to motorists within a roadway section.

A series of tables was generated for this report on ARFs for pole relocation and pole density reduction, as given in the utility pole user's manual by Zegeer and Cynecki (1986). For example, Table 5 in this synthesis report shows the expected ARFs for reducing pole density at a site with an ADT of 25,000 vehicles. Table 5 shows separate calculations for different pole offsets (3, 7, 15, and 25 feet from the road), using different pole densities before and after improvement (10 to 70 poles per mile, in increments of 10 poles per mile). Similarly, Table 6 corresponds to the expected ARFs for increasing pole offset from the roadway edge-line for an ADT of 25,000 vehicles. Table 6 gives separate calculations for densities of 20, 40, and 75 poles per mile, using poll offsets of 2 to 15 feet from the road before improvements and 6 to 30 feet after improvements. The full user's manual (Zegeer and Cynecki 1986) includes more tables than this synthesis report.

**Table 4. Accident (crash) reduction factors (Zegeer and Parker 1983).**

| Pole Offset Before Relocation (Feet) | Expected Percent Reduction in Utility Pole Accidents — Pole Offset After Relocation (Feet) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 20-30 |
| 4 | 30 | 42 | 49 | 55 | 60 | 63 | 69 | 70 | 72 | 73 | 77 |
| 5 | | 36 | 43 | 50 | 56 | 59 | 65 | 67 | 69 | 70 | 74 |
| 6 | | | 27 | 36 | 43 | 48 | 55 | 57 | 60 | 62 | 67 |
| 7 | | | | 22 | 31 | 37 | 46 | 48 | 52 | 54 | 59 |
| 8 | | | | | 22 | 29 | 39 | 42 | 45 | 48 | 55 |
| 9 | | | | | | 18 | 30 | 33 | 37 | 40 | 48 |
| 10 | | | | | | | 22 | 25 | 30 | 33 | 42 |
| 11 | | | | | | | | 18 | 24 | 27 | 36 |
| 12 | | | | | | | | | 11 | 15 | 25 |
| 13 | | | | | | | | | | 11 | 22 |
| 14 | | | | | | | | | | | 17 |

Note: 1 foot = 0.3 m

**Table 5. Accident (crash) reduction factors associated with reducing pole density (Zegeer and Cynecki 1984).**

ADT LEVEL 25000. POLE OFFSET 3. FEET

| POLE DENSITY BEFORE IMPROVEMENT (POLES/MILE) | POLE DENSITY AFTER IMPROVEMENT (POLES/MILE) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 10. | 20. | 30. | 40. | 50. | 60. | 70. |
| 20. | 11. | - | - | - | - | - | - |
| 30. | 21. | 10. | - | - | - | - | - |
| 40. | 28. | 19. | 9. | - | - | - | - |
| 50. | 34. | 26. | 17. | 9. | - | - | - |
| 60. | 39. | 31. | 24. | 16. | 8. | - | - |
| 70. | 44. | 36. | 29. | 22. | 15. | 7. | - |
| 80. | 48. | 41. | 34. | 27. | 20. | 14. | 7. |
| 90. | 51. | 45. | 38. | 32. | 25. | 19. | 13. |

ADT LEVEL 25000. POLE OFFSET 15. FEET

| POLE DENSITY BEFORE IMPROVEMENT (POLES/MILE) | POLE DENSITY AFTER IMPROVEMENT (POLES/MILE) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 10. | 20. | 30. | 40. | 50. | 60. | 70. |
| 20. | 12. | - | - | - | - | - | - |
| 30. | 21. | 11. | - | - | - | - | - |
| 40. | 29. | 19. | 10. | - | - | - | - |
| 50. | 35. | 26. | 18. | 9. | - | - | - |
| 60. | 41. | 32. | 24. | 16. | 8. | - | - |
| 70. | 45. | 37. | 30. | 22. | 15. | 7. | - |
| 80. | 49. | 42. | 35. | 28. | 21. | 14. | 7. |
| 90. | 52. | 46. | 39. | 33. | 26. | 20. | 13. |

ADT LEVEL 25000. POLE OFFSET 7. FEET

| POLE DENSITY BEFORE IMPROVEMENT (POLES/MILE) | POLE DENSITY AFTER IMPROVEMENT (POLES/MILE) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 10. | 20. | 30. | 40. | 50. | 60. | 70. |
| 20. | 12. | - | - | - | - | - | - |
| 30. | 21. | 10. | - | - | - | - | - |
| 40. | 28. | 19. | 9. | - | - | - | - |
| 50. | 35. | 26. | 17. | 9. | - | - | - |
| 60. | 40. | 32. | 24. | 16. | 8. | - | - |
| 70. | 44. | 37. | 30. | 22. | 15. | 7. | - |
| 80. | 48. | 41. | 34. | 27. | 21. | 14. | 7. |
| 90. | 51. | 45. | 39. | 32. | 26. | 19. | 13. |

ADT LEVEL 25000. POLE OFFSET 25. FEET

| POLE DENSITY BEFORE IMPROVEMENT (POLES/MILE) | POLE DENSITY AFTER IMPROVEMENT (POLES/MILE) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 10. | 20. | 30. | 40. | 50. | 60. | 70. |
| 20. | 12. | - | - | - | - | - | - |
| 30. | 22. | 11. | - | - | - | - | - |
| 40. | 30. | 20. | 10. | - | - | - | - |
| 50. | 36. | 27. | 18. | 9. | - | - | - |
| 60. | 41. | 33. | 25. | 16. | 8. | - | - |
| 70. | 46. | 38. | 30. | 23. | 15. | 8. | - |
| 80. | 50. | 42. | 35. | 28. | 21. | 14. | 7. |
| 90. | 53. | 46. | 40. | 33. | 26. | 20. | 13. |

**Table 6. Accident (crash) reduction factors associated with increasing lateral pole offsets (Zegeer and Cynecki 1984).**

ADT LEVEL 25000. POLE DENSITY 20. POLES/MILE

| POLE OFFSET BEFORE IMPROVEMENT (FEET) | POLE OFFSET AFTER IMPROVEMENT (FEET) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 6. | 8. | 10. | 12. | 15. | 17. | 20. | 25. | 30. |
| 2. | 49. | 58. | 63. | 67. | 72. | 74. | 76. | 80. | 82. |
| 3. | 35. | 46. | 53. | 58. | 64. | 66. | 70. | 74. | 77. |
| 4. | 22. | 35. | 44. | 50. | 56. | 60. | 64. | 69. | 72. |
| 5. | 11. | 25. | 35. | 42. | 50. | 54. | 59. | 64. | 68. |
| 6. | - | 16. | 27. | 35. | 44. | 48. | 54. | 60. | 64. |
| 7. | - | 8. | 20. | 29. | 38. | 43. | 49. | 56. | 61. |
| 8. | - | - | 13. | 23. | 33. | 38. | 44. | 52. | 57. |
| 9. | - | - | 6. | 17. | 28. | 33. | 40. | 48. | 54. |
| 10. | - | - | - | 11. | 23. | 29. | 36. | 45. | 51. |
| 11. | - | - | - | 5. | 18. | 24. | 32. | 41. | 48. |
| 12. | - | - | - | - | 13. | 20. | 28. | 38. | 45. |
| 13. | - | - | - | - | 9. | 16. | 24. | 35. | 42. |
| 14. | - | - | - | - | 4. | 12. | 21. | 31. | 39. |
| 15. | - | - | - | - | - | 8. | 17. | 28. | 36. |

ADT LEVEL 25000. POLE DENSITY 40. POLES/MILE

| POLE OFFSET BEFORE IMPROVEMENT (FEET) | POLE OFFSET AFTER IMPROVEMENT (FEET) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 6. | 8. | 10. | 12. | 15. | 17. | 20. | 25. | 30. |
| 2. | 49. | 57. | 63. | 67. | 71. | 74. | 76. | 79. | 82. |
| 3. | 35. | 45. | 53. | 58. | 63. | 66. | 69. | 74. | 76. |
| 4. | 22. | 35. | 43. | 50. | 56. | 60. | 64. | 68. | 72. |
| 5. | 11. | 25. | 35. | 42. | 50. | 54. | 58. | 64. | 68. |
| 6. | - | 16. | 27. | 35. | 44. | 48. | 53. | 59. | 64. |
| 7. | - | 8. | 20. | 29. | 38. | 43. | 48. | 55. | 60. |
| 8. | - | - | 13. | 22. | 33. | 38. | 44. | 51. | 57. |
| 9. | - | - | 6. | 17. | 28. | 33. | 40. | 48. | 54. |
| 10. | - | - | - | 11. | 23. | 28. | 36. | 44. | 50. |
| 11. | - | - | - | 5. | 18. | 24. | 32. | 41. | 47. |
| 12. | - | - | - | - | 13. | 20. | 28. | 37. | 44. |
| 13. | - | - | - | - | 9. | 16. | 24. | 34. | 42. |
| 14. | - | - | - | - | 4. | 12. | 20. | 31. | 39. |
| 15. | - | - | - | - | - | 8. | 17. | 28. | 36. |

ADT LEVEL 25000. POLE DENSITY 75. POLES/MILE

| POLE OFFSET BEFORE IMPROVEMENT (FEET) | POLE OFFSET AFTER IMPROVEMENT (FEET) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 6. | 8. | 10. | 12. | 15. | 17. | 20. | 25. | 30. |
| 2. | 49. | 57. | 63. | 67. | 71. | 73. | 76. | 79. | 81. |
| 3. | 35. | 45. | 52. | 57. | 63. | 66. | 69. | 73. | 76. |
| 4. | 22. | 35. | 43. | 49. | 56. | 59. | 63. | 68. | 71. |
| 5. | 11. | 25. | 35. | 42. | 49. | 53. | 58. | 63. | 67. |
| 6. | - | 16. | 27. | 35. | 43. | 48. | 53. | 59. | 63. |
| 7. | - | 8. | 20. | 28. | 38. | 42. | 48. | 55. | 60. |
| 8. | - | - | 13. | 22. | 32. | 37. | 44. | 51. | 56. |
| 9. | - | - | 6. | 16. | 27. | 33. | 39. | 47. | 53. |
| 10. | - | - | - | 11. | 22. | 28. | 35. | 44. | 50. |
| 11. | - | - | - | 5. | 18. | 24. | 31. | 40. | 47. |
| 12. | - | - | - | - | 13. | 20. | 27. | 37. | 44. |
| 13. | - | - | - | - | 9. | 15. | 24. | 34. | 41. |
| 14. | - | - | - | - | 4. | 11. | 20. | 31. | 38. |
| 15. | - | - | - | - | - | 8. | 17. | 28. | 36. |

The Zegeer and Parker (1983) study also identified the following several factors associated with the likelihood of serious injuries and deaths for the 9,583 utility pole crashes in the research database:

- **Pole type.** For roadway sections where pole offsets from the road were 10 feet or less, wooden poles (compared to metal poles) were associated with a significantly greater severity of injuries and deaths. This outcome is likely because many of the metal poles in the database were luminaire poles with frangible bases that break away when struck.
- **Horizontal curvature**. Utility poles on roadway sections with increasing curvature experienced more severe utility pole crashes (when compared to tangent sections) for certain speed limit categories (i.e., speed limits under 35 mph and over 50 mph).
- **Speed limit**. No significant effect was documented between roadway speed limit and crash severity. This outcome possibly resulted from fewer categories of injury severity (PDO, injury, and fatality) compared to previous studies, such as that of Jones and Baum (1980), which analyzed more detailed data on crash severity.

**Table 7. Summary of relationships between utility pole crash frequency and severity versus roadway factors (Zegeer and Parker 1983).**

| | Variable | Strong Evidence of a Relationship | Some Evidence of Logical Relationship | No Known Relationship |
|---|---|---|---|---|
| Utility Pole Variables | Utility Pole Frequency (Spacing) | f | | s |
| | Lateral Pole Distance from Road | f | s | |
| | Type of Pole Material (Steel, Wood, Concrete) | s | | f |
| | Size of Utility Pole | s | f | |
| | Breakaway Pole Concept | s | | f |
| | Protective devices in front of Pole (i.e. guardrail or crash cushion) | s,f | | |
| Traffic Variables | Traffic Volume (ADT) | f | | s |
| | Traffic Mix (% Trucks, Etc.) | | s | f |
| | Impacting Vehicle Size and Weight | s | | f |
| | Volume/Capacity Ratio | | | f,s |
| | Speed Limit (as an indication of vehicle speeds on a roadway) | s,f | | |
| Highway Geometric Variables | Curvature | f | s | |
| | Superelevation | | f,s | |
| | Grade | f | s | |
| | Roadway Width | | f | s |
| | Shoulder Width and Condition | | f,s | |
| | Number of Lanes | f | | s |
| | Presence of Median | f | | s |
| | Median Width | | f | s |
| | Number of Intersections/Mile | | f | s |
| | Availability of Curb Parking | f | | s |
| | Side Slope | f | s | |
| | Presence of Curb | | f | s |
| Environmental Variables | Pavement Condition | f | | s |
| | Pavement Type | | f | s |
| | Skid Number | f | | s |
| | Urban or Rural | f | s | |
| | One-way or Two-way | | | f,s |

f - frequency related
s - severity related

In summary, crash frequency was clearly related to ADT, pole offset, and pole density, with lesser factors including type and size of pole, roadway curvature, and roadway type (divided or undivided). Crash severity was most related to pole type and roadway curvature. Table 7 summarizes the relationships between (1) utility pole crash frequency and severity and (2) various roadway features, based on a literature review by Zegeer and Parker (1983).

CHAPTER 5

# Identification of Utility Poles in High-Risk Locations

A utility pole in a high-risk location is defined as one placed in a site within the roadway environment where there is an above-average risk of being struck by an errant motorist and where serious injury or death is a likely outcome of such a collision. It has been estimated that no more than 1/10 of 1% (0.001) of utility poles within highway rights-of-way are atypically exposed and thus considered to be at high risk of being struck, as discussed previously. Past research established that identifying and treating these poles not only can reduce the associated crash risk but also can be cost-effective in many situations, as indicated in the cost-effectiveness section of TRB State of the Art Report 9 (Ivey and Scott 2004) and the Gabler, Gabauer, and Riddell (2007) study on New Jersey DOT’s breakaway poles.

The data confirm some common types of roadway environments that can be considered when identifying high- risk locations. Some of these exposure situations are described in Ivey and Scott (2004) and include poles that are located as follows:

- In the critical quadrants of an intersection (Figure 12)
- On the outside of curves (Figure 13), especially on curves where the advisory speed is lower than the design speed of adjacent tangent sections (which can be especially critical at the apex of vertical curves where the S-curve is hidden until the crest is reached)
- On the roadside immediately after, and in line with, a lane termination
- In an area exposed to oncoming traffic in the zone where the pavement narrows significantly
- In the median of divided roadways
- On traffic islands exposed to oncoming traffic
- In an area adjacent to reversed curves when the pole line moves from one side of the roadway to the other side.

The aforementioned roadway environments and conditions are presented and discussed in TRB State of the Art Report 9 (Ivey and Scott 2004, pages 48–51). A single collision is not necessarily synonymous with a high-risk pole, but even a single event should constitute a reason to assess that pole’s location. Figure 13 and Figure 14 both show examples of high-risk poles, with the pole only a few inches outside of the travel lane and on the outside of a horizontal curve; Figure 14 also documents damaged poles.

Several published methods may be useful in determining locations where crashes are probable: for example, by setting up a pole exposure record system or by systematically evaluating the relative exposure within the utility system. Once exposure to collisions is determined as a part of a comprehensive, prioritized, and cost-effective safety program, one or more of the five different analytical methods to identify high-risk poles can be used. These methods are all related to the numeric frequency, collision rate, quality control, crash severity, or some combination of those four characteristics. These approaches are described in TRB State of the Art Report 9 (Ivey and Scott 2004, page 54) and are emphasized in the latest work by Gabler, Gabauer, and Riddell (2007).

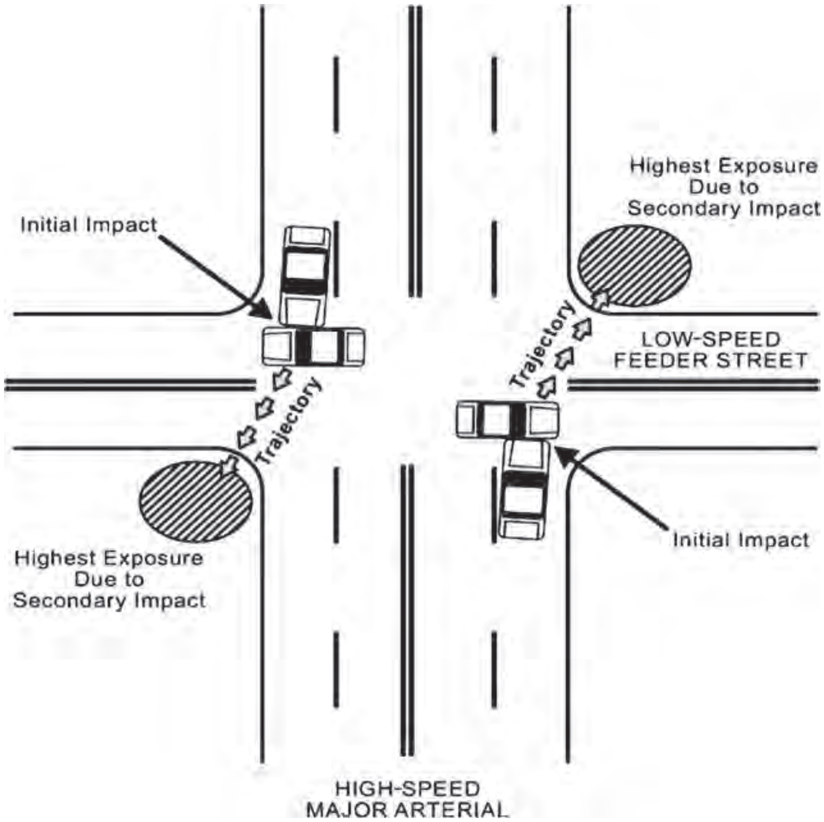



***Figure 12. High-risk intersection zone (Ivey and Scott 2017).***

***Figure 13. Example of high-risk pole locations on the outside of a horizontal curve (Photo: Charles V. Zegeer).***

***Figure 14. Examples of damaged high-risk poles (Photos: Kevin Zegeer).***

TRB State of the Art Report 9 (Ivey and Scott 2004, pages 18–21) describes a three-path approach to reducing utility pole fatalities, consisting of what are termed the Best Offense, Best Bet, and Best Defense strategies, defined as follows, to address utility pole safety problems:

- **Best Offense**. This approach identifies where an overrepresented number of collisions are occurring, assesses available countermeasures, prioritizes these high-risk poles for treatment, and implements the improvements.
- **Best Bet**. This approach involves prioritizing potentially hazardous poles and roadway sections (using statistical prediction algorithms) before a crash history develops and implementing appropriate improvements.
- **Best Defense**. This approach complements the first two and entails striving to meet the recommendations of the *Roadside Design Guide* (AASHTO 2011b) and Ivey and Scott (2004).

The Best Offense requires the documentation of collisions to better pinpoint specific locations or segments of highways where an atypical number of collisions have occurred and are occurring. Such data would be available through police crash reports and UO maintenance records.

The Best Bet is an effort to identify where collisions are most likely to occur in the future. It requires a DOT or UO with knowledge of the roadway system, including utility positions in a right-of-way, to detail where vehicle exposure to poles is most significant. Predictive algorithms are available for this calculation and include traffic density and speed, pole frequency, and pole lateral placement.

The Best Defense also relies on knowledge of the highway and utility systems. Examples include large rigid wooden poles, which present a real danger to passing motorists because the poles are so close to the roadway (Figure 15). More telephone poles are located close to the roadway on a tangent section (Figure 16), which can also pose a high risk of serious injury (Ivey and Scott 2017).

***Figure 15. Examples of high-risk poles too close to the roadway (Photos: Charles Zegeer).***

***Figure 16. High-risk poles along a tangent section (Image: Delaware DOT).***

CHAPTER 6

# Countermeasure Cost-Effectiveness

After individual poles (or a series of poles) along a corridor are identified as high risk based on either utility pole crashes or on pole placement in high-risk locations, the next questions relate to the treatments that may be justified. The second phase of the FHWA study by Zegeer and Parker (1983) addressed quantifying the effects of various treatment options on crash rates. These options, which they also analyzed in terms of potential economic feasibility, pertain to modifying the pole itself (e.g., pole relocation). A different set of countermeasures is discussed later in more detail: those intended to indirectly reduce the number of utility pole crashes by keeping the vehicle on the roadway (e.g., using delineation, lighting, in-advance curve signing) and by applying measures to decrease crash severity (e.g., installing guardrails or breakaway poles).

The Zegeer and Parker (1983) study developed expected crash effects and the cost-effectiveness (i.e., the benefit-cost ratio) of several utility pole treatments, including:

- Placing utility lines underground (and removing the poles)
- Increasing the lateral offset of the poles from the roadway
- Reducing the number of poles (by employing poles for multiple uses, increasing pole spacing, or using poles only on one side of the road)
- Implementing combinations of increasing lateral pole offset and reducing pole density
- Using breakaway poles.

The benefit-cost ratios for each treatment option were based primarily on three factors: (1) the expected reduction in number of utility pole crashes (based on the crash-prediction model), (2) estimates of countermeasure costs (based on cost estimates from utility companies throughout the United States), and (3) the roadside adjustment factor (RAF).

The calculation of RAF was needed to adjust for the effect of any utility pole countermeasure (e.g., pole relocation) based on the presence of trees, steep slopes, and other roadside conditions. For example, when utility poles are repositioned or removed, an out-of-control vehicle that typically would hit the utility pole may instead (1) avoid a collision entirely, (2) strike some other fixed object, or (3) roll over (or down) the side slope. RAFs were projected based on the area type (urban or rural), distance of poles from the roadway (ranging from 2 feet to 30 feet from the road), and coverage of other types of fixed objects (between 0% and 100%). A series of RAFs from 0 to 1.0 was developed to account for a wide range of roadside conditions. The full FHWA report (Zegeer and Parker 1983) provides full details on the benefit-cost process.

This chapter summarizes cost-effectiveness analysis results for each type of countermeasure and the associated outcomes. Appendix C includes cost-effectiveness analysis tables taken from the full FHWA study (Zegeer and Parker 1983). Note that the dollar value of both costs and crash-related safety benefits (i.e., both the numerator and denominator of the benefit-cost calculation) would be considerably greater today than in 1983. Thus, the benefit-cost ratios shown in Appendix C and cited below are primarily intended to illustrate the relative desirability of countermeasure options under various traffic and roadway conditions. More updated calculations of the expected benefit-cost ratios for individual countermeasures can be computed as described in the FHWA's *Selection of Cost-Effective Countermeasures for Utility Pole Accidents—User's Manual* (Zegeer and Cynecki 1986).

## Place Utility Lines Underground and Remove Utility Poles

Removing utility poles altogether and burying the utility lines underground are usually very costly and labor-intensive treatments. For the Zegeer and Parker (1983) report, the costs for installing underground cables were obtained from 21 different utility companies. Such expenses varied widely based on the type of utility poles, voltage of the lines, area type, construction methods, and other factors (e.g., local wages, local material costs, project location). The costs were summarized separately for (1) transmission lines (more than 69 kV), (2) distribution lines of less than 69 kV using conduit, (3) distribution lines of less than 69 kV with a direct bury three-phase line, (4) direct bury one-phase distribution lines of less than 69 kV, and (5) telephone lines.

Based on the benefit-cost analysis, it was generally not cost-effective to shift to underground utility lines for transmission lines, electric lines requiring conduits, or three-phase electric lines because of the high costs associated with these countermeasures. However, placing telephone lines underground (which is much less expensive than running large electric lines underground) produced benefit-cost ratios of more than 1.0 for many circumstances—particularly when the telephone poles were at that time within 5 feet of the roadway and the traffic volume exceeded 5,000 vehicles per day, with a relatively clear and level roadside.

## Relocate Utility Poles Further from the Roadway

This countermeasure focuses on removing all poles currently in a segment and reinstalling them further from the roadway. In the survey of utility companies for the Zegeer and Parker (1983) report, 10 telephone companies and 31 electric companies supplied costs for pole relocation. Such costs were summarized separately as follows:

- Wood power poles carrying less than 69 kV
- Nonwood (metal, concrete, or other) poles
- Steel transmission poles and towers.

In terms of the cost-effectiveness of pole relocation, the greatest benefit-cost ratios result where the average pole distance from the roadway can be at least 10 feet after treatment. Also, relocating telephone poles is generally more cost-effective than repositioning electric poles because of the considerably lower cost of moving telephone poles, which are typically much smaller and lighter than most electric poles (Zegeer and Cynecki 1984).

For example, if 30 telephone poles are currently located an average of 2 feet from the roadway with an ADT of 10,000 vehicles on a road with 35% coverage of other roadside objects, relocating the poles to 20 feet from the road would produce an estimated benefit-cost ratio of 3.44. (Of course, the benefit-cost ratio would be less than 3.44 for similar situations with more than 30 poles per mile because of the increased costs for relocating the additional poles.)

## Reduce Pole Density

Efforts to reduce utility pole density can include three different types of strategies: (1) increasing the spacing between poles, (2) using a pole line for multiple purposes (e.g., to carry both electric and telephone lines), and (3) employing one line of poles instead of two pole lines. Increasing pole spacing may require the use of larger and stronger poles to carry the heavier loads placed on each individual pole. Of course, when struck by motor vehicles, such larger and sturdier poles might result in more severe crash outcomes. Regarding cost-effectiveness, the cost of increasing pole spacing as a treatment for an existing line of poles can be comparable to the cost of pole relocation (Zegeer and Cynecki 1984).

Shared-use utility poles (with multiple utility features on a single line of poles) have been a common utility company practice for many years. This approach includes using each pole to carry some combination of electric, telephone, cable, television, or other communication services (in addition to supporting luminaires along highway rights-of-way) in an effort to decrease distribution costs. The costs for implementing changes in pole density depend on the configuration of the utility poles and lines and on the ease of repositioning the poles.

Converting from two lines of poles to one line generally requires eliminating poles from the side of the road where the poles are closest to vehicle travel. In some situations, with a double line of poles on the same side of the road, each pole line carries different types of utility lines. In this circumstance, reducing pole density would involve removing the line of poles closest to the road and then doubling up utility lines on the other poles.

The utility pole crash-prediction model was also applied to calculate the safety benefit of fewer poles per mile under various roadway conditions, whether the treatment is increasing pole spacing (for poles on one side of the road) or employing multiple-use poles (where poles on one side of the road are removed and utility lines are doubled up on the other side of the road). The benefit-cost ratios were generally lower than 1.0 for most examples of increasing pole spacing because the cost incurred is basically the expense of moving every pole, which would generate only a minimal safety benefit from marginally fewer poles. However, multiple-use poles were generally cost-effective in many situations because their use usually involves removing all poles on one side of the road and doubling lines on the remaining poles on the other side of the road. This approach often eliminates about half of the total poles without any new pole installations, thus producing greater safety benefits and lower costs compared to increasing the spacing between all poles.

## Combine Reducing Pole Density and Relocating Poles Further from the Road

A combined treatment is less common because it not only requires space to move the pole further from the road but also asks the UO to use structurally stronger poles to handle the added weight per pole that characterizes increased spacing. The costs for this combined countermeasure were calculated based on cost figures obtained from numerous UOs for various pole treatment situations. In some circumstances, the combined treatment was cost-effective, particularly where the telephone poles originally were within approximately 5 feet of the roadway but could be moved at least 10 or 15 feet from the road (with no additional cost for purchasing right-of-way).

## Convert to Steel-Reinforced Safety (Breakaway) Poles

This countermeasure involves modifying selected poles that are in high-risk locations (e.g., very close to the road on the outside of a horizontal curve) by incorporating steel-reinforcement hardware to the pole in two places, enabling it to break away when impacted by an errant vehicle. This breakaway feature more gradually decelerates a vehicle and thus results in a less severe impact for the vehicle and its occupants (when compared to regular wood or steel poles). Several decades ago, five states (Kentucky, Massachusetts, Texas, Virginia, and Maryland) initiated the use of such breakaway pole features on a trial basis, and they are currently employed by a few states (as shown in the results of the STA survey). The cost of converting to steel-reinforced features at the time of their introduction in the 1980s was around $1,000 per pole but likely is higher now.

The cost-effectiveness calculation for steel-reinforced safety poles is more difficult than that for other pole treatments because of limited information about the relative reduction in crash severity to be expected after converting selected poles from a wood base to a steel-reinforced breakaway base. Zegeer and Parker (1983), in their study for FHWA, computed the estimated benefit-cost ratio based on two different assumptions regarding effectiveness in reducing the number of crashes. These assumptions are calculated as follows: if the poles are not moved, this steel-reinforced pole treatment would not change crash frequency but could reduce the number of crashes resulting in injuries and fatalities by an assumed 30% or 60%. Under the 30% decrease (the first assumption), this pole treatment was primarily cost-effective (i.e., with a benefit-cost ratio exceeding 1.0) for roads with ADT rates higher than 20,000 vehicles, pole offsets of 2 feet or less, and fewer than 60 poles per mile.

If the same pole treatment produced a 60% reduction in pole crashes associated with injuries and fatalities (the second assumption), it would be cost-effective under a wide variety of roadway situations—ADT rates as low as 5,000 vehicles, a broad range of pole offsets, and even some poles that originally were 10 or 15 feet from the road. The pilot study of steel-reinforced poles in five states did demonstrate that such poles were highly effective in terms of a much-reduced severity of outcomes for the pole strikes that did occur.

## Assess Countermeasure Cost-Effectiveness

Notably, the benefit-cost values are based on an average set of conditions in terms of utility pole types, pole placement and density, ADT, and condition of the roadside where the utility poles are located. Therefore, a more detailed site-specific analysis is recommended before the final selection of a countermeasure, and the utility pole user's manual (Zegeer and Cynecki 1986) allows for such a more refined cost-effective analysis to select the optimal solution for a given roadway and utility pole circumstances.

## Select Cost-Effective Countermeasures

On the basis of the calculated benefit-cost ratios for the utility pole treatments discussed above, Zegeer and Cynecki (1986) developed a series of tables in their study for FHWA, giving an overview of the countermeasures that are generally cost-effective (i.e., those with a benefit-cost ratio of 1.0 or higher) for various combinations of traffic conditions and roadway features. These guidelines, described in more detail below, apply to urban, suburban, and rural roadways on divided and undivided roadways, but they do not pertain to freeways. The guidelines include roadways with vehicle ADTs between 1,000 and 60,000 vehicles, pole offsets of 2 feet to 30 feet, pole densities from 0 to 60 poles per mile, and other various roadside conditions. These guidelines are intended to assist the user in identifying the countermeasure options that are likely to be cost-effective (Zegeer and Cynecki 1984).

To illustrate how these guidelines were displayed, Table 8 corresponds to cost-effective countermeasures for utility poles with one-phase electric distribution lines (less than 69 kV) along urban streets. Matrix cells were created, consisting of various combinations of pole offset distances, pole densities, ADT figures, and roadside coverage of other fixed objects.

The matrix cells in Table 8 contain letters that correspond to cost-effective countermeasures such as underground utility runs (U), relocation of utility poles further from the road (R),

**Table 8. Illustration of cost-effective countermeasures: one-phase distribution lines in urban areas with various site and utility pole conditions (Zegeer and Parker 1983).**

Legend
U = Underground utility lines
(R) = Relocate utility poles to 10 feet (3 m)
R = Relocate utility poles to 20 feet (6 m)
B = Breakaway poles (assuming a 60 percent reduction in injury and fatal utility pole accidents)
(B) = Breakaway poles (assuming a 30 percent reduction in injury and fatal utility pole accidents will result)
M = Multiple pole use (reduce pole density by 50 percent)

| | | ADT = 1000-5000 | | | | ADT = 5000-10,000 | | | | ADT = 10,000-20,000 | | | | ADT = 20,000-40,000 | | | | ADT = 40,000-60,000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Roadside Condition | | | | Roadside Condition | | | | Roadside Condition | | | | Roadside Condition | | | | Roadside Condition | | | |
| Pole Offset (Feet) | Pole Density (Poles/Mile) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) |
| 2 | <40 | U | | | | U R B | U B | U B | B | U (R) B | U (R) B | U R B | U B | U (R) (B) | U (R) (B) | U (R) (B) | U (R) (B) | U (R) (B) | U (R) (B) | U (R) (B) | U (R) (B) |
| | 41-60 | U | U | U | U | U | U | U | U | U R B | U R B | U B | U B | U (R) (B) | U (R) (B) | U (R) (B) | U (R) (B) | U (R) (B) | U (R) (B) | U (R) (B) | U (R) (B) |
| | >60 | U | U | U | U | U | U | U | U | U | U | U | U | U (R) B | U R B | U R B | U B | U (R) (B) | U (R) (B) | U (R) (B) | U (R) (B) |
| 5 | <40 | | | | | | | | | U | | | | U B | U B | U B | B | U R (B) | U R (B) | U R (B) | U (B) |
| | 41-60 | U | | | | U | | | | U | U | U | | U | U | U | U | U B | U B | U B | U B |
| | >60 | U | U | | | U | U | U | | U | U | U | U | U | U | U | U | U B | U B | U B | U B |
| 10 | <40 | | | | | | | | | | | | | U | | | | U B | U B | U B | B |
| | 41-60 | | | | | | | | | U | | | | U | U | | | U | U | U | |
| | >60 | | | | | U | | | | U | | | | U | U | U | | U | U | U | |
| 15 | <40 | | | | | | | | | | | | | | | | | U | U | U | |
| | 41-60 | | | | | | | | | | | | | U | | | | U | U | U | |
| | >60 | | | | | | | | | | | | | U | | | | U | U | U | |
| 20 | <40 | | | | | | | | | | | | | | | | | U | | | |
| | 41-60 | | | | | | | | | | | | | | | | | U | | | |
| | >60 | | | | | | | | | | | | | U | | | | U | | | |

Note: 1 foot = 0.3 m
1 pole/mile = 0.6 poles/km

multiple-use poles (M), and breakaway poles (steel-reinforced safety poles) (B). Some matrix cells also show circled letters (an R or a B). A circled R is defined as a pole relocation that results in a 10-foot distance from the road, compared to a 20-foot distance for an uncircled R. A circled B indicates an assumed 30% reduction in injuries and fatal crashes after the installation of a breakaway device, compared to the assumed 60% decline in injuries and fatal crashes for an uncircled B. An empty matrix cell indicates that none of those countermeasures is generally cost-effective for the given combination of conditions.

A quick review of Table 8 reveals that most of the matrix cells in the upper right corner contain several symbols because, in this part of the table, poles are close to the roadway, with high vehicle volumes. Therefore, there is a high likelihood of utility pole crashes—as well as numerous possible cost-effective solutions for these roadway situations. The cells in the lower portion of the table typically display few or no symbols, which means that none of the listed countermeasures is generally cost-effective (because the poles already were moved further from the road).

Also, in Table 8, the columns that represent a flat roadside with no other fixed objects exhibit more cost-effective treatments (i.e., more symbols in the matrix cell) when compared to similar roadways with higher (up to 60%) coverage of fixed objects. This pattern results because clear and flat roadsides will experience fewer crashes involving trees or other objects after moving or removing the poles (e.g., through pole relocation or newly run underground utilities).

Consider, for example, a roadway section with 65 poles per mile, each pole located an average of 2 feet from the road; an ADT of 30,000 vehicles; and 35% coverage of roadside obstacles. The cell corresponding to this set of conditions shows several cost-effective countermeasures, including relocation of poles to 10 feet from the road (assuming that adequate right-of-way exists and that an R is circled), breakaway poles (B), and underground utility lines (U). To determine which of these treatments is optimal for this set of conditions, a more formal analysis is required, using more specific site conditions. A similar roadway with the poles at an average of 20 feet from the road would show none of these countermeasures as cost-effective (i.e., no symbols in any of those cells in the lower part of the table).

If the poles in the preceding example were telephone poles (i.e., smaller and less costly to relocate or move underground), any of these countermeasures for treating the poles would produce higher benefit-cost ratios than those for poles carrying electric lines. In addition, the corresponding table for telephone poles in urban areas would display symbols (i.e., cost-effective options) for more situations than in rural areas (Table 9) as a result of the lower treatment costs (Appendix C). Table 9 provides a similar overview of cost-effectiveness countermeasures for

**Table 9. Illustration of cost-effective countermeasures: telephone poles in rural areas with various site and utility pole conditions (Zegeer and Parker 1983).**

| | | ADT = 1000-5000 Roadside Condition | | | | ADT = 5000-10,000 Roadside Condition | | | | ADT = 10,000-20,000 Roadside Condition | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pole Offset (Feet) | Pole Density (Poles/Mile) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (<10%) | Medium Fixed Object Coverage (<35%) | High Fixed Object Coverage (<60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (<10%) | Medium Fixed Object Coverage (<35%) | High Fixed Object Coverage (<60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (<10%) | Medium Fixed Object Coverage (<35%) | High Fixed Object Coverage (<60%) |
| 2 | <40 | U (R) M | U (R) M | U (R) M | (R) | U B (R) M | U B (R) M | U B (R) M | U B (R) | U B (R) M | U B (R) M | U B (R) M | U B (R) |
| | 41-60 | U (R) M | U (R) M | U (R) M | U (R) M | U (R) M | U (R) M | U (R) M | U (R) M | U B (R) M | U B (R) M | U B (R) M | U B (R) M |
| | >60 | U (R) M | U (R) M | U (R) M | U (R) M | U (R) M | U (R) M | U (R) M | U (R) M | U (R) M | U (R) M | U (R) M | U (R) M |
| 5 | <40 | U (R) M | R | | | U (R) M | U (R) | (R) | (R) | U (R) M | U (R) | U (R) | (R) |
| | 41-60 | U (R) M | U R M | U | | U (R) M | U (R) M | U (R) | | U (R) M | U (R) M | U (R) | U (R) |
| | >60 | U (R) M | U R M | U M | U | U (R) M | U (R) M | U (R) M | U | U (R) M | U (R) M | U (R) M | U (R) |
| 10 | <40 | | | | | U R | | | | U R | | | |
| | 41-60 | U M | | | | U M | | | | U R M | U | | |
| | >60 | U M | U M | | | U M | U M | | | U R M | U M | U | |
| 15 | <40 | | | | | | | | | U | | | |
| | 41-60 | U M | | | | U M | | | | U M | | | |
| | >60 | U M | | | | U M | | | | U M | U | | |
| 20 | <40 | | | | | | | | | | | | |
| | 41-60 | | | | | U | | | | U | | | |
| | >60 | U M | | | | U M | | | | U M | | | |

Note: 1 foot = 0.3 m
1 pole/mile = 0.6 poles/km

rural telephone poles instead of larger poles carrying electric lines. Traffic volume categories are lower in Table 9 than in Table 8; i.e., the ADT categories in Table 9 range from 1,000 to 20,000 vehicles per day, compared to an ADT of 1,000 to 60,000 vehicles in Table 8, reflecting lower vehicle volumes for rural roads versus urban roads. Similar tables are included in Appendix C for larger poles that carry one-phase and three-phase electric distribution lines. No separate chart is provided for transmission poles (transmission towers) because none of the treatments were cost-effective as a result of the extremely high cost of relocating such poles (more than $1 million per pole) or transferring the power lines underground.

Notably, the information in Table 8 and Table 9 is based on general guidelines regarding cost-effective countermeasures for a given combination of site conditions, relying on average treatment cost figures obtained from dozens of utility companies across the nation. Furthermore, this research on cost information (i.e., crash costs and countermeasure outlays) used for these analyses were developed for FHWA in the 1980s by Zegeer and Parker (1983), and no study since then has recalculated crash-reduction factors or cost-effectiveness tables and charts incorporating more current cost information. Therefore, the charts and tables presented here (and in Appendix C) are primarily designed to give a sense of what types of countermeasures are likely to be worthy of further consideration.

To obtain a more precise assessment of benefit-cost ratios for the countermeasures considered for a given roadway situation, it is important to use the more detailed cost-effectiveness analysis in the FHWA user's manual produced by Zegeer and Cynecki (1986).

Neither Table 8 nor Table 9 includes countermeasures such as installing a guardrail or adding reflective bands on poles.

As noted previously, for any discussion of cost-effectiveness in this report, the cost of crashes and countermeasure expenditures have increased since Zegeer and Parker (1983) conducted the referenced study, so their data should be applied with caution. Therefore, to compute more up-to-date benefit-cost ratios for various utility pole treatments, the same CMF values noted in this report could be used, but with more updated costs for crashes and pole treatments for a given roadway situation. However, researchers would need to obtain newer countermeasure costs from the utility company that owns and maintains the poles under consideration for a safety improvement.

Of course, more up-to-date crash costs also are available from FHWA for use in a benefit-cost analysis. Specifically, the economic assessment of a given countermeasure, such as a treatment involving utility poles, requires knowledge of the cost of a traffic crash at various severity levels (e.g., PDO, injuries, fatalities). More recently, Harmon, Bahar, and Gross (2018) provided information on crash costs for analyzing highway safety.

A thorough benefit-cost analysis also requires input on the interest rate, effectiveness of the countermeasure (CMF), and cost of the treatment. Expenditures for a specified countermeasure (e.g., pole relocation) should be obtained from the relevant STA or UO and should be based on the previous cost of implementing similar treatments under local conditions.

CHAPTER 7

# Current Countermeasure Practices

## Studies of Individual Treatments, Past and Present

Fox, Good, and Joubert (1979) found that poles placed at the curb in Australia are three times more likely to be struck compared to those located 10 feet from the travel lane. Zegeer and Parker (1983) also concluded that the chance of a vehicle striking a utility pole diminishes greatly if the pole is 10 feet or more from the road. Poles at intersections, at lane drops, and on the outside of horizontal curves are also at higher risk of collisions than poles on tangent sections. The strategy of relocating high-risk poles to lower risk sites can often be cost-effective.

Good, Fox, and Joubert (1987) conducted a study in Australia for *Accident Analysis and Prevention*, performing an in-depth analysis of 879 utility pole crashes at 795 sites and an analysis of 627 crash-involved vehicles. This study included crash modeling, use of crash costs, and development of cost-effective treatments for utility pole crashes. The authors also assessed vehicle factors that may be contributing to utility pole crashes. They concluded that pole crashes are four times more likely when roads are wet and that side and oblique impacts are generally more severe (because of occupant space penetration). This study also demonstrated that 65% of pole crashes entailed frontal impacts.

A majority (61%) of pole crashes involved male drivers, typically in their late teens to early 20s. Alcohol was cited as a contributing factor in 38% of the crashes in the study, compared to a rate of 15% for other documented pole crash cases. More severe crashes occurred on curves than on tangent sections. Vehicles with tire tread depths of less than 3 mm were overrepresented in the pole crashes, particularly on wet roads, and underinflated tires increased the likelihood of crashes. Lower vehicle mass (i.e., smaller cars) exhibited more severe injury levels. Side-impact crashes were more severe than head-on crashes because of the shorter distance to the occupant compartment and the relative strength of the side of the vehicle. The Good, Fox, and Joubert (1987) study then calculated "loss reduction" (i.e., the reduction in crash-related costs), which revealed findings including the following:

- Pole removal was the most cost-effective method.
- Crash barriers and attenuators would not be a cost-effective loss-prevention measure in urban areas.
- Crashes involving breakaway or yielding luminaire poles resulted in significantly lower societal costs compared to those of rigid luminaires. (Similar information on the effectiveness of breakaway or yielding utility poles is not currently well established.)

Ray, Troxel, and Carney (1991) investigated the characteristics of side-impact collisions with fixed objects in the United States, using two data sources from NHTSA: the National Accident Sampling System (NASS) and FARS. The study cited trees and utility poles as the most frequently struck fixed objects—and as the types of roadside obstacles causing the most severe personal injuries. In terms of the part of the vehicle impacted in fixed-object crashes, the front of the vehicle collided first in about 65% of crashes, compared to 24% of crashes involving a side-impact. Of all fixed-object types struck, utility poles accounted for 26.3% of the side-impact crashes recorded in FARS and 30.2% of those in NASS. The study also found an overrepresentation in fatal crashes associated with "narrow objects" (e.g., trees and utility poles).

Ray, Troxel, and Carney (1991) also determined that side impacts with "broad objects" such as guardrails were related to 18% of the collisions, with 12% of the fatalities. The side-impact fatality rate for guardrails was five times less than the same rate for trees and utility poles. They also noted that the chance of a motorist being involved in a fatal side-impact crash was three times higher on curved sections of roads compared to tangents. In the conclusions, they observed that the sides of vehicles are not as rigid as the fronts and that a near-side occupant in a side-impact crash is no more than 6 to 8 inches from the fixed object.

Ray, Troxel, and Carney (1991) concluded:

> Certainly the greatest improvements could be realized if trees and utility poles were removed from certain hazardous locations along the roadway. Such relocation and removal programs will require state, county, and city officials to come committed to reducing this type of accident in their jurisdictions. . . . Roadside designers must make every effort to keep trees and poles away from the roadway, hardware developers must develop safety appurtenances for this scenario, automotive manufacturers must design more crash-worthy vehicles for side impacts, and local governments must commit themselves to removing fixed objects from hazardous locations. . . .

Marquis (2001) conducted a study for the Maine DOT with the objective of identifying common factors associated with utility pole crashes to better specify corrective measures and to update current policies and reduce the number of such crashes. This study was performed in response to Maine's recognition that it had a problem (ranking ninth nationally based on utility pole fatal collisions per miles driven) and that its policy was to relocate poles only when a roadway section is reconstructed or rehabilitated. Marquis (2001) analyzed a database of utility pole crashes between 1994 and 1998 to pinpoint risk factors, and a questionnaire was sent to all 50 states regarding their policies. The study recommended potential safety measures to enhance Maine policies. Some of the following conclusions were reached about factors related to utility pole crashes:

- Most utility pole crashes (87% of fatalities and 74% of crashes) occurred on rural roads.
- Excessive speed and driver inattention were common crash factors.
- Utility pole crashes often occurred on roads with little or no shoulder.
- Steep-side slopes were also commonly cited in utility pole crashes.
- Utility poles in the median or traffic island were also struck.
- At 18% of the utility pole crash sites, poles were situated on both sides of the road.

Marquis (2001) recommended several steps to improve utility pole safety in Maine and to modify the state's utility pole location policy. These recommendations included annual reviews of crash records and the consideration of high-crash sites for improvement.

Marquis (2001) recommended the following offsets for pole placement:

- Greater than 8 feet on roads with 25–35 mph speed limits
- Greater than 14 feet on roads with 40–45 mph speed limits
- Greater than 24 feet on roads with speed limits exceeding 50 mph.

Other recommendations by Marquis (2001) include the following:

- Utility poles should be located at least as far back as the rear slope of the ditch lines.
- Guy wires should be placed on the back side of utility poles (i.e., further from the road than the closest point on the poles).

- Poles should be eliminated on traffic islands, in medians, and across from T-intersections. Alternative safety structures should be used on poles that cannot be moved.
- For roadways with poles on both sides of the road, the poles on one side should be removed, and all utilities should be carried on the pole line on the other side of the road.
- The presence of poles on the outside of horizontal curves should be reduced, and the offset distance from the road should be increased where slopes exceed 4:1.

If poles cannot be placed an adequate distance from the road, the Marquis (2001) report recommends considering "alternative safety structures" (e.g., steel-reinforced breakaway poles, low-profile concrete barriers, guardrails, or soft concrete cushions).

Jinsun and Mannering (2002) analyzed run-off-road crashes on a 96.6-km (about 60-mile) section in Washington State, using empirical and methodological analysis techniques to study run-off-road crash frequency and severity. The purpose was to provide an indication of the effects of various countermeasure options on reducing the frequency and severity of roadway encroachment crashes. The study accounted for roadway geometrics, roadside geometrics, roadway characteristics, and run-off-road crash frequency and severity. Among its findings: the number of run-off-road crashes can be reduced by avoiding cut slopes, decreasing the number of isolated trees along the roadsides, and increasing the distance between the outside shoulder edge and the light poles. Jinsun and Mannering (2002) also identified various roadway and roadside features that contributed to crash severity.

NCHRP Report 500 is composed of a series of guides in different volumes, including *Volume 8: A Guide for Reducing Collisions Involving Utility Poles* (Lacy et al. 2004). The overall objective of this guide focused on recommending countermeasures to reduce the frequency and severity of utility pole crashes. Also, *Volume 6: A Guide for Addressing Run-Off-Road Collisions* (NCHRP 2003) describes additional measures that might be helpful. The following three overarching objectives were recommended in Volume 8 of NCHRP Report 500 (Lacey et al. 2004):

1. Treating individual utility poles that are in high-crash and high-risk locations
2. Preventing the placement of utility poles in high-risk locations
3. Treating several utility poles along a corridor in an effort to minimize the likelihood of pole crashes by errant vehicles.

Volume 8 of NCHRP Report 500 (Lacy et al. 2004) also encourages highway agencies to adopt a comprehensive approach, including non-engineering practices such as police enforcement of speeding laws, driver information and education programs, improvements in highway safety management systems, and measures to increase seat belt use by vehicle occupants.

The 10 specific strategies described in that NCHRP guide address the three objectives listed above. Strategies 1 through 6 below relate to Objective 1; Strategy 7 focuses on Objective 2; and Strategies 8 through 10 are pertinent to Objective 3.

**Strategy 1. Remove poles at high-crash locations**. This measure involves reviewing crash data to pinpoint those poles that have been struck one or more times in recent years. This strategy will require a field visit to identify these poles, ask questions about whether the poles are necessary at that specific location, and consider whether the poles can be moved to a lower risk location.

**Strategy 2. Relocate poles further from the road at high-crash locations to lower the risk of those sites.** This strategy relates more to multiple poles in a line along a roadway section where collisions have occurred with some of the poles, where the poles are in high-risk locations (such as close to the road on a curvy roadway), or both. Because motorists are more likely to run off the road on curves rather than tangent sections, it follows that poles placed adjacent to the road on the outside of curves are at greater risk of being struck. Such higher risk locations could also be lurking at intersections or lane drops. Poles in traffic islands or at the top of a T-intersection (Figure 17) may also be at higher risk of vehicle collisions.

**Strategy 3. Use breakaway pole features.** The strategy of using a steel-reinforced safety pole or a fiberglass pole is not directed at treating large numbers of poles but instead is an option for treating a few poles that are currently at a vulnerable location and, for practical reasons, cannot be removed or relocated. For example, this strategy may involve one or two poles close to the road on a horizontal curve where no additional right-of-way is available and where moving the pole is not feasible. In such cases, converting the pole to a yielding pole may be both practical and cost-effective in many situations.

**Strategy 4. Provide roadway devices to shield motorists at high-risk locations.** This strategy places a guardrail or other longitudinal barrier in front of the poles. This option would create less of a hazard than the utility pole, even though a guardrail itself represents a fixed object that may produce occupant injuries in a collision. Employing such barriers may be particularly appropriate if the poles cannot be moved. In addition, barriers may be appropriate in locations that also are characterized by trees and other fixed objects or by steep roadside slopes on the roadside, so relocating the utility poles would not resolve the roadside hazard problem.

The criteria for justifying guardrail installation include the following:

- The utility pole is located in the clear zone.
- Relocating or removing the utility pole is not possible because of right-of-way limitations or economic factors such as those associated with large transmission poles (Figure 18).
- Breakaway poles are not an appropriate solution because trees, steep slopes, or other roadside features would reduce the benefit accrued from such a feature.
- A guardrail or barrier would not create a greater hazard than the utility pole.
- A guardrail or barrier will not direct the striking vehicle into a higher risk hazard, such as a large tree or a steep slope.
- The guardrail face will be no closer than 2 feet from the edge of the road. The guardrail or barrier would be positioned with enough space between it and the utility pole so that a striking vehicle will not push the guardrail into the pole.

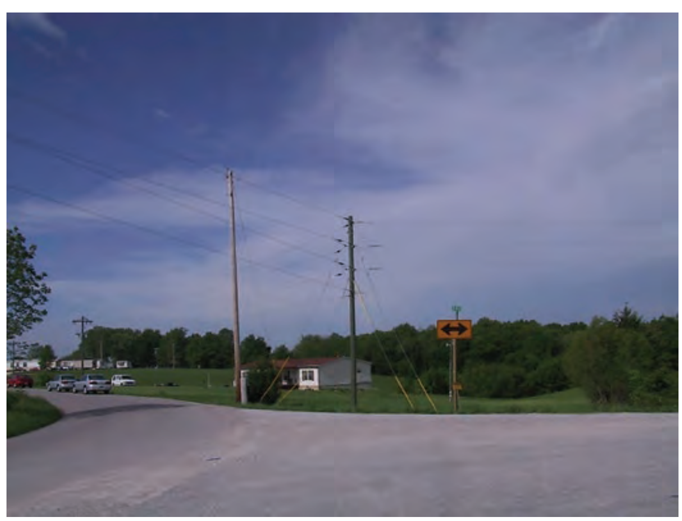


***Figure 17. Example where pole relocation can greatly reduce the risk of utility pole crashes, at the top of a T-Intersection (Photo: Charles Zegeer).***


***Figure 18. Example of utility poles (such as transmission poles) that cannot be relocated, requiring consideration of alternative treatments (Photo: Don Ivey).***

**Strategy 5. Improve the driver's ability to see the utility poles at high-risk locations.** This strategy involves placing a reflective band or reflective markers (delineation) on the poles so that they are more visible at night in the shine of oncoming vehicle headlights. This measure does not reduce crash severity but, in some cases, may help the driver see the poles and take necessary action to avoid them. This projected outcome assumes that the errant vehicle is under some level of control or can be brought back under control after the driver sees the reflective devices. If the vehicle is already out of control, however, such delineation is not likely to reduce the likelihood of a collision.

**Strategy 6. Install traffic-calming measures to reduce vehicle speeds.** This strategy relates to installing roadway geometric treatments to reduce the speed of motor vehicles on roads (in urban and suburban areas) in situations where direct treatments to the utility poles (e.g., pole relocation, shift to underground utility lines) are not feasible. Such measures can include road diets (reducing the number of lanes from a four-lane undivided highway to a three-lane road), installing speed monitoring cameras, narrowing the lane width (by using edge-line markings), installing speed humps, or implementing other countermeasures. Although not considered as traffic-calming measures, other options (e.g., paving the shoulder, installing edge-line rumble strips) are available for treating the roadway to reduce the likelihood of run-off-road crashes. Figure 19 shows an example of traffic-calming measures to reduce vehicle speeds that is based on narrowing the road, which can also provide for safer (and additional) pedestrian crossings.

**Strategy 7. Implement policies and guidelines to discourage positioning utility poles in the recovery area or at high-risk locations.** This strategy adopts utility pole-placement guidelines that are sensitive to siting poles where they are at lower risk of being struck by motor vehicles. Such pole-placement guidelines, which are sensitive to highway safety concerns, can be useful not only when new utilities are installed but also when poles are removed and then reinstalled during construction and reconstruction projects. Examples of such pole-placement guidelines and policies that are geared to improving roadside safety are described in this report in Chapter 9 on case examples from STAs.

**Strategy 8. Install utility lines underground.** This measure focuses on removing the utility poles and burying the lines underground. This strategy is normally quite expensive and therefore

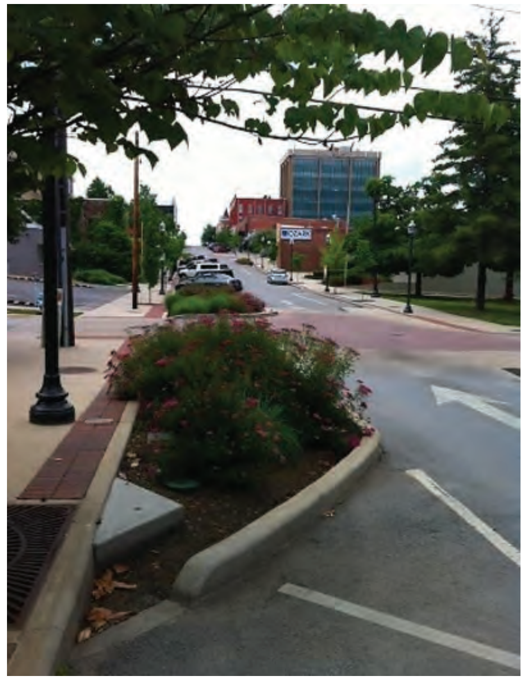


***Figure 19. Example of a traffic-calming measure, with a narrowing road and pedestrian crossings (Photo: Kristen Brookshire).***

is cost-effective primarily along roadways where (1) the poles are very close to the roadway (e.g., 2 feet from the travel lane); (2) a very limited right-of-way means that the poles cannot reasonably be relocated further from the road (because additional right-of-way cannot be purchased); and (3) no other obstacles (such as trees) lie in the clear zone and would still pose crash risks after the utility poles are removed. Installing utility lines underground is actually a fairly common measure used by some jurisdictions, partly for the aesthetic benefits of removing lines of utility poles. A candidate section for underground utilities is shown in Figure 20.

***Figure 20. Example of a good candidate for safety improvement by burying utility lines (Photo: Charles Zegeer).***

**Strategy 9. Relocate poles along a corridor further from the road, to less vulnerable locations, or both.** This strategy involves addressing needed improvements for multiple utility poles along a roadway—not, for example, just a few poles that have been involved in collisions. The goal of this strategy is to relocate a row of poles that is currently placed in the clear zone of a roadway, with all poles located closer to the roadway than is advisable.

**Strategy 10. Reduce the number of utility poles along a roadway section.** Fewer poles represent one obvious method for decreasing the number of pole crashes within a roadway section. In practical terms, this pole reduction can be accomplished in several different ways. (1) Multiple-use poles (shared utilities) require removing the row of poles on one side of the road and then, for sections that currently have poles on both sides of the road, doubling up multiple types of utility lines (e.g., telephone, electric, cable) on a single row of poles while eliminating the row of poles closer to the road. (2) Installing poles with greater spacing between them may certainly have the negative effect of requiring larger and more rigid poles at the longer intervals, therefore possibly intensifying crash severity if one occurs. Many states and UOs already have implemented policies where multiple-use poles are a normal practice that reduces crash risk while lowering ongoing costs of pole maintenance (because fewer poles are in place to maintain) (Lacy et al. 2004).

Mattox (2007) investigated tree and utility pole crashes on nine urban Atlanta, GA, corridors and recommended improvements to state clear zone requirements. The study identified several factors that contribute to run-off-road crash frequency or severity, including driver fatigue or inattention, excessive vehicle speed, driving under the influence of drugs or alcohol, crash avoidance maneuvers, roadway conditions (such as ice, snow, or rain), vehicle component failure, and poor visibility. The study analyzed various treatment options for poles and tree hazards, including implementing the *Roadside Design Guide* (AASHTO 2011b) alternatives—i.e., remove the hazard, relocate the obstacle further from the road, make utility poles less rigid (breakaway poles), enhance the visibility of the object—as well as installing roadway treatments such as edge-line rumble strips, curve delineation, skid-resistant pavements, traffic-calming measures, and pole-visibility features. The analysis concluded that collisions with trees and poles were more likely to occur within 25 feet of an intersection. Mattox (2007) recommended implementation of a policy that avoids installing utility poles within 25 feet of an intersection or else places them 10 feet or more from the roadway.

El Esawey and Sayed (2012) conducted a study for the British Columbia Ministry of Transportation and Infrastructure to assess the effects of placing utility poles at different offsets from roads in Canada. They developed a safety performance function (SPF) based on the collection of data for 1,720 km (about 1,069 miles) of roadway that accounted for 838 utility pole collisions on Canadian roads between 2006 through 2010. Overall, they calculated an average of approximately 0.1 collision per kilometer per year, which was very similar to the figure in the Zegeer and Parker (1983) study. The SPF values developed from this database were based on Poisson and negative binomial mode forms, which had difference prediction outcomes, and were compared with the Zegeer and Parker (1983) model for certain ADT levels and pole densities. El Esawey and Sayed (2012) found several possible reasons for these differences between the Zegeer and Parker (1983) U.S. study and their own Canadian study, including the following factors:

- Different samples (four U.S. states versus roads in British Columbia, Canada)
- Differences in driver, vehicle, and roadway characteristics between the 1980s (United States) and the early 2000s (Canada)
- Differences in the highway class, specifically two-lane and multilane divided and undivided roads in urban and rural areas (U.S. study) versus only rural undivided roads (Canadian study)
- Maturation, that is, possible changes or differences in crash reporting practices between the two studies (where reporting in British Columbia was said to also differ from crash reporting

in other parts of Canada), with the El Esawey and Sayed (2012) nomograph for predicting utility pole crashes shown in Figure 21
- Different model forms and error structures of the prediction models used in the two studies.

El Esawey and Sayed (2012) developed models and nomographs that used basically the same variables as Zegeer and Parker (1983): traffic volume, pole offset, pole density, and a measure of section length, which was accounted for in the Zegeer and Parker (1983) study. El Esawey and Sayed (2012) found that increasing pole offset produced a greater effect on pole crashes than expanding pole spacing, a finding similar to that of the Zegeer and Parker study (1983). El Esawey and Sayed (2012) stated the following:

> The two models (Zegeer and Parker's and the one developed in this study) were shown to be different in terms of the type of data used in the analysis, as well as the methodological approaches employed for developing the predictive model. These two major differences explain to a great extent the dissimilarity in the estimates of the two models.

Carrigan and Ray (2017) focused on the importance of the UOs' responsibility to identify utility poles in high-risk locations and to treat those poles to reduce pole crashes. They present a series of tables and graphs that can be applied to Version 3 of the Roadside Safety Analysis Program (RSAP-V3) (Carrigan and Ray 2011), which quantifies the crash risk associated with various utility pole offsets and pole spacing distances. Carrigan and Ray (2017) explained a quantitative approach for identifying the individual poles that are at the greatest risk for a collision. In particular, this approach calculates the risk for fatal and serious (A-type injury) crashes for city, county, and state roads, based first on using the RSAP-V3 and then on increasing the calculated risk of a collision with individual poles based on their location on the outside of a

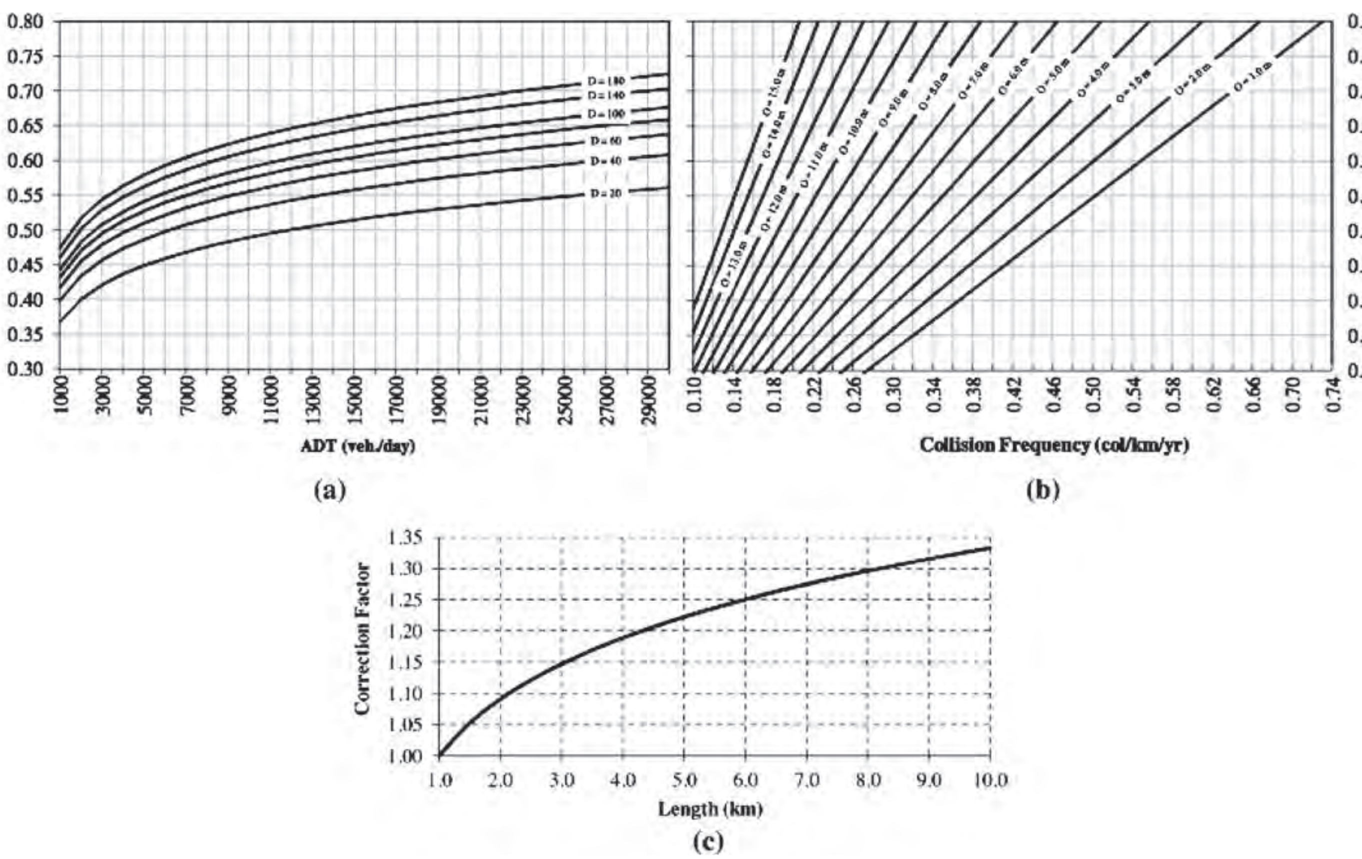



*Figure 21. Nomograph for predicting utility pole crashes (El Esawey and Sayed 2012).*

horizontal curve or on a grade. Carrigan and Ray (2017) stated that this approach is of most value to UOs that are interested in identifying the highest-risk poles and repositioning them to lower risk locations.

## Full Range of Possible Solutions and Countermeasures

While the Zegeer and Parker (1983) study supplied information on expected crash effects and cost-effectiveness, other potential treatments are also available to treat poles classified as high-crash or high-risk poles. Keeping in mind that many of these deaths and injuries could be avoided, many practical solutions and countermeasures are available to address hazardously located utility poles. Some of them are summarized in the rest of this chapter.

The *Roadside Design Guide* (AASHTO 2011b) details the following options for the safe design and siting of new utilities and the relocation of existing utility poles in hazardous locations:

- Increase lateral pole offset
- Increase pole spacing
- Combine pole usage with multiple utilities (joint use)
- Bury electric and telephone lines underground.

Horne (2001) of FHWA proposed a comprehensive group of solutions and countermeasures, as follows, that can be used to address the safety problems associated with hazardously located utility poles:

- Keep vehicles on the roadway by employing the following methods:
  - Use pavement markings and delineators
  - Improve skid resistance and drainage
  - Widen lanes
  - Widen and pave shoulders
  - Straighten curves
- Change pole position or remove poles as follows:
  - Move select poles
  - Decrease number of poles through joint use
  - Decrease pole density
  - Increase lateral offset of poles
  - Increase pole spacing
  - Locate poles where they are less likely to be struck by vehicles (including burying lines underground)
- Use safety devices such as the following:
  - Crash cushions
  - Steel-reinforced safety poles
  - Guardrails
  - Concrete barriers
- Warn motorists of obstacles by using the following:
  - Pole delineation (reflective paint, sheeting, markers on poles)
  - Roadway lighting
  - Warning signs
  - Rumble strips.

CHAPTER 8

# Safety Devices

Many safety devices have been developed, and a few have been pilot-tested and evaluated with good results. Although STAs or LPAs have used some of these safety devices on a case-by-case basis, this synthesis report has not identified any UOs that have adopted these devices for routine use to safeguard the public from crashes with hazardously located utility poles.

Safety devices that would be suitable for shielding vehicles from utility poles are discussed in the *Roadside Design Guide* (AASHTO 2011b), which is widely used by STAs and constitutes an equally valuable guide for UOs. However, UOs have rarely chosen to install such safety devices, instead tending to rely on guides such as the *National Electrical Safety Code* (Institute of Electrical and Electronic Engineers 2017), which does not consider the safety of the highway traveling public.

For years, STAs have proved that structures such as crash cushions, guardrails, concrete barriers, and breakaway or yielding devices are effective in protecting the public from rigid obstacles in rights-of-way; yet, most UOs have overlooked these same proven devices, even when so-called high-risk poles are obvious. A cursory inspection of the *Roadside Design Guide* (AASHTO 2011b) uncovers at least 14 crash cushions, 14 guardrail and end treatments, 2 concrete barriers, and 1 breakaway structure that can be applied to the treatment of identified high-risk poles.

While some of these safety devices were originally tested under the requirements of NCHRP 230 (Michie 1981) or NCHRP 350 (Ross et al. 1993), those documents have now been replaced by the *Manual for Assessing Safety Hardware* (MASH) (AASHTO 2016b). Since the acceptance of that manual and the revision of 2016, most of the guardrail end treatments (e.g., SoftStop, SKT, SLED, and MAX) have met the new MASH (AASHTO 2016b) requirements. Many crash cushions (e.g., QuadGuard, CrashGuard, and Big Sandy) have also been approved under MASH (AASHTO 2016b) requirements.

Guidry and Beason (1992) developed the low-profile concrete barrier, which was tested under NCHRP 350 (Ross et al. 1993) Test Level (TL) 2. Under TL 3, Dobrovolny, Shi, and Bligh (2018) qualified a new design of the low-profile barrier under MASH TL-3 conditions.

The steel-reinforced safety pole (i.e., Hawkins, FHWA, or AD-IV) was originally tested and qualified under NCHRP 230 (Michie 1981) by Ivey and Morgan (1986) and by Alberson and Ivey (1994). These designs have not been retested under NCHRP 350 (Ross et al. 1993) or MASH (AASHTO 2016).

More than 30 safety devices were applicable, according to the *Roadside Design Guide* (AASHTO 2011b), and many more designs have been approved under MASH (AASHTO 2016b). The following relatively low-cost items were cited in the *Roadside Design Guide* (AASHTO 2011b):

- Crash cushion (sand inertia barrels) (page 8–38)
- Guardrail/end treatment (W section extruder) (page 8–13)

- Portable concrete barrier (conventional 32-inch and low-profile 20-inch) (pages 9–8, 9–23)
- Breakaway structure (steel-reinforced safety shape) (page 4–35).

Ivey and Scott (2000) have suggested that safety structures (cushions, rails, or yielding or breakaway devices) in Texas should be required when a UO requests an exception to the STA clear zone policy. If the state chooses to provide the safety structure, the UO would bear the cost of installation and maintenance as long as it chooses to locate poles within the STA clear zone (Ivey and Scott 2000).

Examples of these safety devices are discussed in the rest of this chapter.

## Crash Cushions

Crash cushions ranging from simple and effective sand-filled barrels to the most sophisticated devices (e.g., CrashGuard) are appropriate to shield vehicle occupants from hazardously located utility poles. At least seven approved designs are listed in the 4th edition of the *Roadside Design Guide* (AASHTO 2011b). Various crash cushion designs were first installed as early as 1977 (AASHTO 1977). The most cost-effective crash cushions yet developed are sand-filled barrels, implemented where continual collision recurrences are not expected. Figure 22 shows an installation in Lafayette, LA, with a pole situated in a high-risk location near traffic on a curve where chevrons were also used to better delineate the curve.

## Composite Utility Poles

Foedinger et al. (2003) developed a fiberglass-reinforced composite utility pole designed to absorb vehicle kinetic energy during a collision (Figure 23). The Shakespeare composite utility pole is constructed of filament-wound fiberglass-reinforced polyester that is tapered (from bottom to top) along its 45-foot length. The cross-section is octagonal and hollow at the base and transitions to a hollow circular cross-section near the top of the pole. Some of the advantages of the

***Figure 22. Examples of installations of sand barrel crash cushions (Photos: Don Ivey).***

***Figure 23. Example of a composite breakaway utility pole (Foedinger et al. 2003).***

fiberglass-reinforced pole over traditional wooden poles include weight savings (475 pounds compared to 1,000 pounds), increased service life (80 years of uniform performance compared to 20 to 50 years of declining performance), and reduced maintenance and faster installation.

In demonstration projects, this pole has replaced some atypically exposed wood poles in New Jersey, but no collisions have been recorded.

Gabler, Gabauer, and Riddell (2007) conducted a comprehensive study of energy-absorbing utility poles and steel-reinforced safety poles that was performed for the New Jersey DOT. They found various situations where both energy-absorbing poles and steel-reinforced safety poles were cost-effective, further reinforcing many of the conclusions and approaches to alleviate the human cost of poles in high-risk locations that TRB State of the Art Report 9 (Ivey and Scott 2004) presented.

## Steel-Reinforced Safety Poles

FHWA sponsored research in the early 1980s to develop an economical "yielding" timber utility pole that would increase the safety of passengers in impacting vehicles and would satisfy the design criteria of the utility industry. Consequently, Ivey and Morgan (1986) developed a slip-base design referred to as the Hawkins Breakaway System (HBS). This design consisted of a slip-base mechanism 3 inches above grade and an upper hinge consisting of a band and strap mechanism that allowed the bottom pole segment to rotate in response to a colliding vehicle. Subsequently, the Massachusetts Electric Cooperative and the New England Telephone Company installed 19 experimental HBS poles near Boston. Examples of steel-reinforced safety poles are shown in Figure 24.

The HBS was subsequently improved during field tests in Massachusetts that showed the pole was stronger during wind loads than the new Class 4 wood poles. Buser and Buser (1992) called this modified design the FHWA design. FHWA provided technology application funds in 1989 for experimental installations of the design in Kentucky, where the Kentucky Utilities Company


***Figure 24. Examples of steel-reinforced safety poles (Photos: Don Ivey).***

retrofitted 10 existing wooden poles in Lexington, and again in 1995 in Virginia, where Delmarva Power installed five poles on the Eastern Shore.

Alberson and Ivey (1994) introduced an improved version of the HBS, known as the AD-IV. Improvements to the previous system included switching from a six-bolt circular lower slip-base connection to a four-bolt square slip-base connection and converting the upper connection from a four-strap shearing mechanism to a four-strap/four-bolt design. These changes reduced the amount of material used in the base connection, lowered the cost of the upper hinge, and decreased the maintenance costs. FHWA furnished technology application funds in 1994 for experimental installations of the AD-IV design in Texas, where the Texas Electric Company installed six poles on an urban arterial road between Fort Worth and Dallas.

FHWA required evaluation of all the experimental poles for several years after installation, with the results noted below (Buser and Buser 1992).

Massachusetts evaluated the HBS FHWA design 2 years after installation. During that time, although all poles were exposed to wind, ice, and snow, no pole exhibited failures because of these natural forces. An incident in Massachusetts in 1991 (during Hurricane Bob) displayed the ability of the poles to resist wind loadings that toppled conventional poles. Poles in Massachusetts were hit by errant vehicles five times during the evaluation period, resulting in no serious injuries or deaths, no loss of utility service, no safety problems relative to linemen, and an average repair time of 90 minutes. In all these crashes, utility personnel indicated that the poles could be repaired quicker and more easily than standard poles, primarily because the need to transfer service lines was eliminated. Since the time of the evaluation, it was later reported by Horne (2001) that the poles were observed periodically and that some of them (for unknown reasons) were replaced with conventional poles; however, those that remained were in excellent condition, including both the galvanized steel elements and the wooden pole segments.

Texas evaluated the AD-IV 3 years after installation and reported only one crash (in 1995). This crash involved the one pole in the group that was improperly installed on a 2:1 slope approximately 10 feet from the paved shoulder. The bottom of the slip base was too high, almost 12 inches above the ground line at the part of the base farthest from the traveled lane. An effort was made to regrade the slope to the proper level, but heavy rains immediately before the crash eroded the newly placed soil. Despite that, the pole functioned during the collision, and no serious injuries occurred. The car frame snagged on the lower plate of the slip base, clearly increasing the deceleration of the vehicle, and the delay in slip-base activation fractured the middle length of the pole and tilted part of the pole in the ground. As a result, the pole was completely replaced. In the 3 years the AD-IV poles were in place at the time of the evaluation, the poles weathered several instances of high winds, including a hailstorm that destroyed the roof and west wall of virtually every building that was not sheltered by trees or other buildings. Texas Electric Company engineers noted that some wind gusts were as high as 80 mph and that some conventional poles were downed. The AD-IVs sustained no damage during these weather events.

Kentucky evaluated the modified HBS FHWA design 2 years after installation, reporting that the poles performed well in high winds (up to 80 mph) and that maintenance costs included only those expenses necessary to straighten the upper segments of the poles. Such maintenance was unnecessary thereafter because wood shrinkage became minimal after 1 to 2 years of exposure. The poles were not located in areas known for crashes; thus, as expected, none of the poles was hit during the evaluation period.

Virginia evaluated the modified HBS FHWA design 2 years after installation and reported no maintenance costs or problems, despite several instances of high winds. No reports were filed citing pole damage or even modest deformation.

## Low-Profile Barrier

The low-profile barrier is simply a short portable concrete barrier (20 inches tall). It has been used extensively in construction zones in Texas. In short lengths, low-profile barriers can be placed to prevent vehicle entry into an area where a utility pole stands in the needed clear zone. The low-profile barrier is qualified now under MASH TL-2. In Des Moines, IA, a low-profile barrier was erected in the median to shield drivers from trees as well as from light poles and fixed aesthetic features. The barrier terminates with a sloped-down end section where the median narrows adjacent to left-turn lanes. At a height of only 20 inches, the barrier has a minimal visual impact. As a mitigation technique, the barrier is expected to reduce crash severities. During a design process that incorporates such a feature, it is important to consider that the installation of the low-profile barrier may also affect pedestrian movements, potentially discouraging crossings at unmarked mid-block locations.

## Guardrails and Various Terminals

Short sections of guardrail are sometimes used to shield hazardously located utility poles, as illustrated in Figure 25.

## Breakaway Guy Wires

FHWA developed and approved several breakaway guy wire systems for use on the National Highway System. The starting point for breakaway guy wire designs was provided by an operational breakaway guy wire connection that was developed and successfully tested in 1986 under an FHWA-sponsored research project, NCHRP 230 TL-3. Details of the design are presented in the FHWA report, *Safer Timber Utility Poles* (Ivey and Morgan 1985). The breakaway guy attachment is intended for use where the anchor guy will be exposed to vehicular traffic, particularly when the anchor guy extends toward traffic. If no records are available on the number of collisions that involve utility anchor guys within road and street rights-of-way, such collisions probably still do occur, resulting in injuries and deaths. An illustration of a breakaway guy cable is shown in Figure 26.

***Figure 25. Example of guardrail and extruder terminal (Photo: Don Ivey).***

## Delineation

FHWA and the Maryland State Highway Administration initiated a pilot study in 1999 to delineate utility poles and other fabricated fixed objects within the highway right-of-way. The study was designed to cost-effectively enhance roadside safety when removal, relocation, and shielding of manufactured fixed objects were not feasible. Recognizing that about 5% of Maryland's highway-related fatalities resulted from collisions with utility poles, FHWA and the Maryland State Highway Administration met with representatives from Allegheny Power, Bell Atlantic, Pepco, and BT&E to coordinate the delineation of a sampling of poles. Pilot roadway sections totaling 70 miles were selected based on crash data and geometrics. All fabricated fixed objects within the pilot roadway sections were delineated with a 6-inch yellow reflective sheeting material (Figure 27). It is considered probable that delineation had a positive effect, but follow-up studies were not sufficiently comprehensive to confirm that effect.

***Figure 26. Example of a breakaway guy wire (Source: Delaware DOT).***

***Figure 27.*** ***Examples of reflective tape on utility pole* (left) *and reflective panel* (right) *(Photos: Kevin Zegeer).***

## Buried Duct Network of Cables

Slavin and Najafi (2010) developed the buried duct network for FHWA to accommodate utility cables along roads and highways. It represents a departure from conventional direct bury construction methods for utility lines (electric power, telephone, and cable television), which lays cables in a trench along the local distribution route. The buried duct network offers an opportunity for conveniently and safely completing cable upgrades at a low incremental cost to the utilities and their customers by using a joint-use upgradable system. Such a system is designed to encourage and support the installation of belowground utilities, thereby minimizing construction difficulties and hazards, including the proliferation of pole lines. In this research, a set of two full-scale field trials was planned and executed at the University of Texas at Arlington: one in Monroe, NC, and one in Massachusetts (Figure 28).

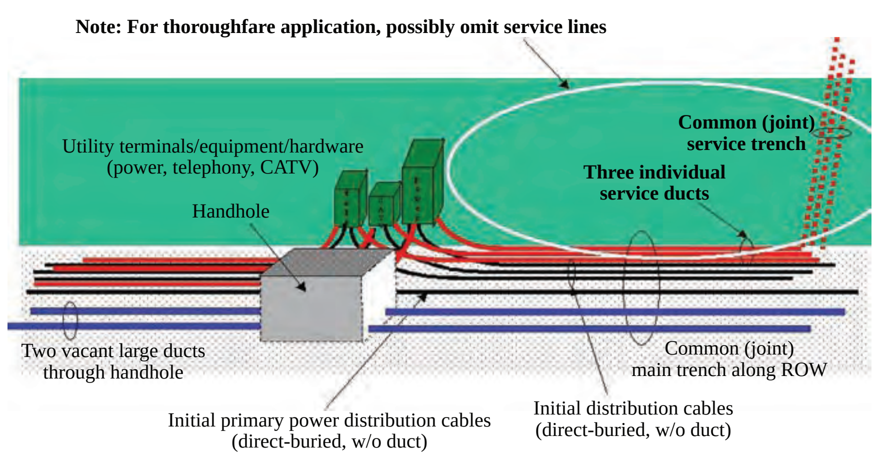



***Figure 28.*** ***Diagram of buried duct network of utility cables.***

CHAPTER 9

# STA Case Examples

Relative to utility pole safety, the federal regulation at 23 CFR 645.209(k) (CFR 2011) reads as follows:

> When the transportation department determines that existing utility facilities are likely to be associated with injury or accident to the highway user . . . the highway agency shall initiate . . . in consultation with the affected utilities, corrective measures . . .

According to FHWA guidance in its program guide (FHWA 2003), the intent of this regulation is for each STA to work with the relevant UOs to reasonably and cost-effectively develop and implement programs to systematically remove, relocate, or mitigate hazardously located utility poles.

As envisioned in the federal regulation, a utility pole crash-reduction program should contain the following essential elements:

- Identification of utility poles in hazardous locations
- Analysis of hazardously located poles and development of countermeasures
- Establishment of a goal for removing, relocating, or mitigating utility poles situated in hazardous sites
- Actual removal, relocation, or mitigation of hazardously located utility poles.

Once specific corrective actions are identified, the state or local agency expects that implementation will be pursued through a prioritization process that takes into account available resources, planned replacement and upgrading for both utility and highway physical plant, and overall crash-reduction potential.

To be effective, this corrective program must be undertaken as a joint effort by the highway authorities and the affected utilities. UOs working closely with their respective STAs can produce an effective process for identifying problem areas and establishing schedules for corrective actions. Wherever possible, such schedules should take into consideration each UO's planned activities, online upgrades, replacements, and other relevant concerns. The preferred approach to a corrective program includes an orderly, planned, and effective process of safety improvements over time that would take into account the costs to both the highway user and the utility consumer.

In accordance with these regulatory constraints, most STAs have established policies for locating new utility poles within highway rights-of-way. Appendix D details the current FHWA guidance on utility pole policies. Appendix E includes examples of state activities for treating utility pole and tree safety problems, as taken from the FHWA report on best practices (Jones 2016). Although most STAs have established policies for locating new utility poles within highway rights-of-way, only a few STAs have adopted policies to address existing utility poles in high-risk locations.

The rest of this chapter discusses efforts by the Washington State DOT, Georgia DOT, New Jersey DOT, North Carolina DOT, and an anonymous DOT to improve the safety of existing utility poles in high-risk locations.

## Washington State DOT

Washington State DOT (WSDOT) policies for utility pole placement and safety are directly shaped by its utility accommodation practices. Utilities are authorized to occupy state highway rights-of-way under franchises with a 25-year term. In the case of poles, placement and design must comply with the standards in effect at the time of the installation or franchise renewal. As it happens, a significantly large number of franchises for utility poles are temporally clustered so that their respective 25-year terms expire within a few years of one another. This mass expiration of franchises and the ensuing scramble for renewals results in large numbers of poles that no longer comply with WSDOT control zone standards because of either changed design requirements or modified highway characteristics.

When large numbers of franchises expire within a similar time frame, the affected utility companies are often surprised to learn that renewal will require significant unanticipated capital investment to correct control zone deficiencies. Such companies seek to work with WSDOT to limit the extent of actual relocations. For its part, WSDOT recognizes that utility companies have limited funding available for control zone mitigation and that the public interest lies in focusing funding to maximize safety benefits. As part of the ensuing coordination, WSDOT then reexamines its policies to consider incorporating new approaches and innovations that may lend themselves to the current conditions.

Between 1989 and 1991, during one of the mass renewal periods, WSDOT updated its policy to adopt a "cost-effective selection procedure" as a tool to justify alternatives to relocation, and implemented an "annual mitigation target" program for utilities to address compliance according to an annual plan. This approach relieved utility companies of the need to address all noncompliant poles in a short time period. The next major control zone policy revision occurred in 2014—not coincidentally, 25 years later.

WSDOT's latest policy revision combines its system to categorize poles (into one of three risk location categories) and RSAP-V3. As long as poles are categorized as Location II (not high risk), have no record of being struck, and fall below a certain designated risk threshold (via RSAP-V3), they may remain in place for a new 25-year franchise term, thus allowing the utility to target locations where this combination of conditions is not achievable.

Utility objects are classified as WSDOT Location I, II, or III objects as follows:

- Location I objects include aboveground fixed (unyielding, non-traversable) utility objects located within the control zone (1) outside of horizontal curves where the advisory signed speeds for the curve are 15 mph or more below the posted speed limit of that section of highway; (2) within the turn radius area of public grade intersections; (3) at sites where a barrier, embankment, rock outcropping, ditch, or other roadside feature is likely to direct a vehicle into a utility object; and (4) within 5 feet horizontally beyond the edge of the usable shoulder.
- Location II objects include all fixed utility objects positioned within the control zone that are not classified as Location I or III objects.
- Location III objects include fixed utility objects, located either outside the control zone or in the control zone, that are mitigated by an alternative countermeasure (e.g., sited in inaccessible areas, shielded, or constructed as a breakaway).

The WSDOT utility object relocation effort generally requires that (1) new utility objects must be placed outside the control zone; (2) existing utility objects must be moved or mitigated in conjunction with highway construction or reconstruction projects; and (3) other existing utility objects must be repositioned or mitigated systematically.

The state supplies additional information about the WSDOT objective of eliminating utility object collisions in accordance with Washington State's Strategic Highway Safety Plan (Washington State DOT 2010) and offers guidance on the placement of aboveground utilities within WSDOT highway rights-of-way in Chapter 9 (Control Zone Guidelines) of the WSDOT Utilities Manual M 22-87 (Washington State DOT 2019).

## Georgia DOT

Georgia has an active utilities coordination program, the Utility Pole Safety Program. The impetus for this program is the Georgia Utilities Coordinating Council (GUCC). Through its more than 35 chapters in seven regions of the state, the GUCC provides an overall cooperative process to exchange information and resolve conflicts in the utility and public sectors. It also maintains standing and ad hoc committees to address mutual issues, including the Clear Roadside Committee, which is composed of members from the Georgia DOT (GDOT) and from the aerial UOs (i.e., electrical, telecommunications, and cable television industries).

Recognizing the disproportionate number of utility pole crashes in Georgia and other southeastern states, the Clear Roadside Committee initiated efforts to improve policies for placing utility poles along public rights-of-way in Georgia. This work involved developing a plan to relocate as many potentially hazardous utility poles as possible to a safer distance from the travel way or to meet clear zones on U.S. and state routes. This plan was created by identifying critical roadway sections based on prior crash history and prioritizing these areas for mitigation. FHWA recognized this innovative effort in 1998 with its presentation to the GUCC of the Best Overall Operational Improvement Biennial Safety Award. The current Utility Pole Safety Program assesses crash data every 2 years to program the projects as safety funds become available.

By consensus, the Clear Roadside Committee recognizes U.S. and state routes as the most critical. GDOT's Traffic Operations Section prepared a report documenting crashes involving utility poles during a consecutive 3-year period and based on 3-mile stretches of road. The routes were prioritized based on the total number of crashes (not just fatal crashes) and the feasibility of pole relocations. Not surprisingly, most of the identified sites were in metropolitan areas, with the top 10 ranked sites, historically, in the metropolitan Atlanta area. However, as more funding becomes available, the Clear Roadside Committee plans to expand the program into other areas of the state.

Clear Roadside Committee recommendations for pole relocations can range from moving the poles a few feet in certain urban low-speed areas to as much as 30 feet in some rural areas. After route selection, the stakeholders meet in the field to walk the route and determine which poles to relocate and how far back the poles can be moved. In addition, during such field checks, other factors may become evident that would make a pole ineligible for relocation, e.g., absentee property owners, proximity of underground utilities, historic trees, endangered species, and Americans with Disabilities Act (ADA) factors. Because the Georgia active utilities coordination program does not allow the purchase of any rights-of-way, all poles are relocated within the existing right-of-way footprint. In some cases, the pole owner will seek additional easements to accommodate the proposed relocations. In addition, the projects must obtain certifications and clearances from the Office of Environmental Services and the Office of Right-of-Way.

On a typical project, the aerial UOs enter into a split-cost (50-50) force account agreement with GDOT for performance of the work. Reimbursement criteria in Chapter 4 of the GDOT *Utility Accommodation Policy and Standards* (Georgia DOT 2018) read as follows:

> Projects shall be identified and programmed based on crash data and other traffic data to indicate there will be a high probability of measurable results benefiting the traveling public. Projects will normally require at least 50% participation from the utilities toward the in-kind replacement cost. Costs including right-of-way, engineering and administration of the in-kind relocation cost may be counted toward the Utility's share whether included in the agreement or a separate estimate to support the Utility's contribution to the project. The Utility may upgrade its facility in conjunction with the work but any costs attributable to the upgrade shall not be counted toward the minimum share to be borne by the Utility.

As of April 2019, five Clear Roadside Committee projects had been undertaken in Metro Atlanta. Two are complete; one is nearing completion; one is midway through the work; and one just began. The two completed projects apparently have had a very positive effect on their surroundings—the areas have improved and been regenerated. These successes reiterate the need to continue studying pole safety and to plan for mitigations that achieve a positive impact on communities over time.

Successful implementation of pole relocation projects necessitates coordination and cooperation from multiple entities so that work is completed efficiently. Once the pole owner (typically an electric provider) has relocated its targeted facilities, it becomes especially critical for other stakeholders to relocate and adjust their infrastructures in a timely fashion. Over the years, GDOT has seen more non-utility infrastructure (e.g., traffic signal interconnects, cameras, wireless telecommunications equipment, license plate readers) attached to utility poles. In urban areas, ADA accessibility must be incorporated before, during, and after construction, and buried utilities that may conflict with pole relocations also must be considered.

Additional information about the GDOT Utility Pole Safety Program is supplied in Chapter 8 of the GDOT *Utility Accommodation Policy and Standards* (Georgia DOT 2018).

## New Jersey DOT

Gabler, Gabauer, and Riddell (2007) investigated New Jersey's experience with utility pole crashes and collisions based on New Jersey crash records from 2003–2005 and on FARS data for 2000–2004. They found that each year in New Jersey, approximately 10,000 vehicle occupants were in crashes involving utility pole impacts. With this in mind, the New Jersey DOT (NJDOT)—in conjunction with researchers Gabler, Gabauer, and Riddell (2007)—developed the Utility Pole Mitigation Program (UPMP) to identify and improve utility poles in the highest-risk crash locations. They selected 20 sites for mitigation that were not part of any active design or construction effort.

The UPMP included a pilot project on the use of energy-absorbing poles at some locations. These poles differed in many ways from their breakaway counterparts made of wood and steel.

The energy-absorbing hollow poles featured composite construction consisting of filament-wound fiberglass-reinforced polyester. These poles were 45 feet long, with a wide octagonal cross-section on the lower portion that transitioned to a narrow circular cross-section near the top. The poles were designed to collapse and to elongate upon impact (as opposed to breaking away and potentially falling into traffic). Gabler, Gabauer, and Riddell (2007) observed no excessive occupant risk factors in either of two separate crash tests.

While NJDOT initially encountered hesitation from the utility companies invited to participate in the UPMP, continued outreach eventually produced an agreement for replacing and installing fiberglass poles in accordance with the policy when possible.

Composite poles offered several advantages over traditional wooden poles in terms of weight, service life, and maintenance. For example, composite poles weigh 475 pounds while wooden poles come in at 1,000 pounds; the service life for composite poles is 80 years with consistent performance, but the service life for wooden poles totals only 20 to 50 years, with declining performance; and composite poles have no maintenance requirements, but wooden poles must be maintained every 5 to 7 years.

## North Carolina DOT

When the North Carolina DOT (NCDOT) determines that an existing utility facility represents a potential hazard or poses an unacceptable risk to highway users, NCDOT consults with the affected utility and initiates corrective measures that will provide a safe highway environment. Available corrective measures include changes to the utility or highway facilities; such measures are prioritized to achieve maximum safety benefits in the most cost-effective manner.

Corrective measures are managed as a joint effort between the utility and NCDOT to identify problem areas and establish mitigation schedules. Whenever possible, these schedules take into consideration both utility and NCDOT planned activities, upgrades, and replacements to create an orderly and effective process for safety improvements.

Exceptions to the NCDOT policy are allowed if the UO can demonstrate that extreme hardships or unusual conditions justify the exception and that alternative measures can be undertaken to fulfill the intent of the policy. The response to a request for exception includes an evaluation of the design, environmental mitigation, safety, and economic effects that would result from granting the exception as well as a consideration of any other pertinent information.

## Anonymous DOT

One anonymous STA started negotiations in the late 1990s with the utility industry to improve pole safety. The utilities advocated a voluntary system to remove poles from strategic locations, envisioning that a targeted approach would produce the best improvements to safety. The STA pulled crash data to identify these strategic locations, which demonstrated that the greatest impact would be on conflict points (such as intersections, driveways, and auxiliary lanes). These areas were identified as “control zones” in a series of drawings. Utilities would not be prohibited from the control zones, but the utility would be expected to voluntarily relocate poles according to new construction criteria rather than, as they historically did, keeping the poles in place per federal-aid non-freeway criteria for resurfacing, restoration, and rehabilitation (RRR).

However, in the next couple of years, the utility companies voluntarily relocated such poles in only a few cases, arguing that they were not legally obligated if the pole had not been hit while meeting RRR criteria and that the STA could not claim that the pole constituted a safety issue under those conditions. The data were not sufficient for that type of analysis, so it was just a qualitative judgment that additional offset in the control zone (sometimes as little as 1 to 2 feet) would produce some tangible safety improvement. Subsequently, the department decided that voluntary compliance was insufficient and asserted that it should have the authority to order poles to be relocated outside of the control zones. Because new construction projects already held the poles to the new construction criteria, the control zones were applied only to poles in RRR construction projects.

The STA started rulemaking to add control zones requirements to its new utility guidelines. The utilities balked because this approach had progressed far beyond the idea of voluntarily and cooperatively improving safety, as they initially agreed to do. The most critical utility poles were located in control zones. These poles handled multidirectional aerial crossings and were already optimally sited in many cases. Thus, the utilities were facing the possibility of the state ordering the relocation of pole utilities underground or off of rights-of-way without any crash history. Worried that this would set an unacceptable precedent, UOs demanded a way to evaluate each location to prevent unnecessary relocations. Furthermore, the utility industry would concede to this new rule requirement only if it were truly that important to safety. Moreover, the utilities argued that if the control zone requirements actually were that central to safety, surely the STA would impose the same requirements on its own aboveground objects. Therefore, to preserve the STA's authority to order the UOs one day to move poles located in control zones to sites off the rights-of-way or to bury the lines underground, other obstacles in the STA's control zones would need to be moved as well. The STA then adopted new utility guidelines for control zones, including an exception process.

Over the next decade, the STA received and approved more than 125 exceptions for control zones. In all instances, the requests were resolved to the satisfaction of the STA and the utilities through an evaluation of how the permitting was performed, the project type, and the crash history. Never once was a utility ordered to take its poles off the right-of-way or bury the lines underground.

During the process of considering control zones, STA officials determined that the STA cannot order a UO to relocate a pole off the right-of-way or to run lines underground because of a control zone violation. In addition, the STA did not want to hold all roadside features to the control zone requirements. Furthermore, the data were not sufficient to justify the control zone requirements, and the department could not quantify the benefits of using control zones. Thus, the previously discussed documentation for the exception process apparently did not provide any real protection or benefit.

STA officials also decided that enforcement of control zones for utility poles added to the expense, effort, and complexity of a project. Furthermore, employing control zones seemed to be a source of constant confusion and frustration for all participants.

Based on these experiences, the latest guidelines incorporated an evaluation process for any pole within RRR construction project limits that had a crash history and no longer met control zone criteria.

During the last 10 years, all newly permitted utility pole lines were placed according to the STA's "new construction requirements." For rural areas, the requirement called for installing the poles not only as close to the right-of-way line as practical but also outside the clear zone. For urban areas, the poles were required to be as close to the right-of-way line as practical but no closer than 4 feet from the face of curb. This requirement applied in all cases: during new construction, during RRR projects, during a reconstruction project, or in the absence of an ongoing project. However, for a proposed RRR project, existing poles were allowed to remain in place unless the crash data showed a crash history for a specific pole. In such a case, the existing pole was evaluated and moved to a safer location, and the possibility of burying the specific utility line underground was considered. If the evaluation indicated that a relocation was unnecessary, the requirements allowed the pole to remain, but if the highway was later reconstructed, all poles then were required to meet "new construction criteria."

This case example is anonymous to protect the identity of the STA and the UO in the state (e.g., to accommodate a situation such as a tort claim against the STA).

## Other Case Examples

In addition to the previous STA case examples, Appendix E provides additional case examples of several STA practices regarding tree and utility pole safety, taken directly from an FHWA report (Jones 2016).

Moreover, the following resources are currently available for review online and detail many of the findings highlighted in this chapter:

- Additional information on the WSDOT objective of eliminating utility object collisions: Washington Strategic Highway Safety Plan (Washington State DOT 2010) and online at http://targetzero.com/pdf/targetzeroplan.pdf
- Guidance on placement of aboveground utilities within WSDOT highway rights-of-way: Chapter 9 on control zone guidelines in the state's utilities manual (Washington State DOT 2019) and online at https://www.wsdot.wa.gov/publications/manuals/fulltext/M22-87/Utilities.pdf
- Additional information about the GDOT Utility Pole Safety Program: Chapter 8 of GDOT's policy and standards (Georgia DOT 2018) and online at http://www.dot.ga.gov/PartnerSmart/utilities/Documents/2016_UAM.pdf
- Information on energy-absorbing pole installations: New Jersey breakaway poles and energy-absorbing poles (Gabler, Gabauer, and Riddell 2007, p. 8) and online at https://www.sbes.vt.edu/gabler/publications/Reports/FHWA-NJ-2007-018_Final-Report.pdf
- Additional guidance on accommodating utility poles on highway rights-of-way: NCDOT *Utility Policy Manual* (North Carolina DOT 2014) and online at https://connect.ncdot.gov/municipalities/Utilities/UtilitiesDocuments/Utilities%20Policy%20Manual.pdf
- Information on incorporating utility pole safety into roadway design: NCDOT *Roadway Design Manual* (North Carolina DOT 2017) and online at *https://connect.ncdot.gov/projects/Roadway/Pages/Roadway-Design-Manual.aspx*.

CHAPTER 10

# Utility Owner Case Examples

Efforts to contact or interview UOs by U.S. mail, email, or telephone were for the most part ineffectual. Of the UOs contacted, four (designated UO1 through UO4) reported various approaches to the roadside safety problem, but one of these no longer considered its roadside safety program (RSP) as active.

The case examples below summarize activities being conducted by four UOs. These case examples are intended to represent the wide variation in UO approaches (and non-approaches) to the roadside safety problem.

## Utility Owner Case Example 1

UO1 covers the major portion of a state in the Great Lakes region. Representatives of UO1 responded comprehensively to our initial survey and provided considerable additional information by telephone. UO1's 1.8 million customers are distributed over 65,000 miles of roadway and include an estimated 1.6 million utility poles within roadway rights-of-way.

UO1 representatives are well informed on the overall problem of roadside safety and use several approaches to determine where changes are indicated in their system. Working with the state DOT and applying, in general, its guidelines for accomplishing appropriate clear zones on rights-of-way, UO1 employs state-compiled heat maps to visualize the relative need for relocating existing facilities or for engineering initial facility locations during new construction. These maps are color coded, with accident histories signified by green (low number of crashes), yellow (medium number), and red (high number). The red areas are accorded special consideration.

UO1 also uses the car pole code method, which continually documents where pole collisions are causing service outages. This maintenance record documentation would in general identify the types of collisions that are sufficiently severe to disrupt service, which presumably would also be those collisions most likely to cause serious passenger injuries. These data illustrate the clear relationship between atypically exposed poles and loss of revenue due to system downtime.

UO1 does not normally install concrete barriers, crash cushions, energy-absorbing deformable poles, or steel-reinforced safety poles (breakaway designs) although UO1 is aware of small cushions for low-speed collisions.

## Utility Owner Case Example 2

UO2 representatives indicated that in 2017, a new state utility accommodation manual was published with guidelines for the placement of poles during new construction and during periods of major facility modification. The state manual before that included less rigorous guidelines, including placement of poles as "close as practicable to the ROW line."

UO2 is, on rare occasions, contacted by the state DOT about modification of facilities that are determined to be atypically exposed to vehicle collisions. In the past, in special cases, guardrails or curbs were recommended. UO2 has never considered crash cushions, concrete barriers, or energy-absorbing poles or breakaway devices. In a recent example of alternatives for meeting the setback guidelines, an installation of rumble strips on a narrow asphalt concrete-surfaced pavement shoulder was approved and paid for by UO2.

In the general case of UO2 requesting a "design alternative," the UO must meet comprehensive requirements, including alternative routing of the electric service transmission elements (i.e., the pole line itself). Sometimes the state DOT does not approve design alternative requests; e.g., a recent proposal for new facilities to transmit power to and from a solar plant installation was rejected.

## Utility Owner Case Example 3

UO3 covers 850 square miles in a southern state with a service area population of about 1 million. UO3 tries to conform, where possible, to state and federal guidelines concerning pole placement, with the usual exceptions generated by roadway widening and installations where roadways were not originally constructed.

In 1989, UO3 responded to negative publicity regarding its use of concrete poles after several severe crashes by implementing an RSP, and independent contractors assigned to that task developed recommendations, as reported by Ivey and Scott (2004).

UO3 then used those recommendations to develop its in-house safety program, adopting a management directive that incorporated much of what the contractors recommended. This directive was eventually superseded by an engineering and construction services procedure in 2006 (revised in 2007). During that period, some pole sites were changed, usually because of pole movement or roadway design changes initiated by the STAs. UO3 attempted no installation of crash cushions, guardrails, or breakaway structures, instead opting for pole movement as the preferred solution.

At this time, UO3 no longer uses the 2007 procedure, attempts to comply with STA policies for pole placement within rights-of-way, and sees no current need for an in-house RSP.

## Utility Owner Case Example 4

UO4 services primarily urban customers in a mid-size southern city with a population of 120,000. UO4 encompasses 53 square miles and provides electricity to 67,000 customers. Its facilities are located on the rights-of-way of 1,300 miles of roadway.

UO4's formal RSP began in 2000 with the adoption of a public safety enhancement project. It has been in continual operation since that time and remains operational today. Its accomplishments included provision of crash cushions on two major transmission poles on the outside of a parkway curve, movement of some poles with a significant crash history, redesign with the city of several intersections, and delineation of many poles near primary thoroughfares.

The two major steel transmission poles suffered two severe collisions in 1999. Since 2000, when the sand inertia crash cushions were installed on these poles, six major collisions have occurred at the two sites, requiring repair or replacement of the crash cushions. However, no severe injuries were associated with the crash cushion events.

Although UO4 has implemented selected site improvements, as indicated by maintenance experience, it is now beginning a crash history analysis based on records for the preceding 5 years to identify current candidates for safety-related system modifications. UO4 offers an effective model for other UOs, illustrating the positive relationship between increased public safety and public relations.

CHAPTER 11

# Conclusions

In 2017, the latest year for which data are available, 887 fatal utility pole crashes occurred in the United States, accounting for 914 fatalities. These numbers were about the same as those in recent years but lower than such fatality numbers from a decade or two ago. UOs own the poles involved in these crashes, but most of these poles are located on public road or street rights-of-way, which are the responsibility of STAs or LPAs.

Gaps exist in current knowledge on exemplary guidelines related to pole placement. Not enough is currently known about how STAs can effectively identify and track utility pole crashes and high-risk locations and how STAs can implement such methods.

## Study Purpose

This synthesis report is designed to summarize the strategies, policies, and technologies that STAs and UOs employ to address utility pole safety concerns. Information was gathered from a comprehensive review of the literature and also the results from STA surveys. Specific areas of interest for this synthesis report include methods to identify problem poles and high-risk locations, pole-placement policies, strategies and countermeasures to reduce the risk of pole-related collisions and resulting injuries and deaths, and available funding sources for implementing countermeasures. Case studies were also developed for exemplary STAs and UOs, highlighting some of their utility pole safety activities.

## Results of the STA Survey

Of the 50 STAs contacted for this study, 92% (46 of 50) responded to the written survey or answered the survey questions during phone interviews. Valuable information was acquired regarding the current state of practice with respect to safety procedures for utility poles. The survey identified safety programs, guidelines, and countermeasures that STAs employ to improve utility pole safety.

## Utility Placement Guidelines

Although a great majority of STAs referred to AASHTO guidance such as its Green Book (AASHTO 2011a) and *Roadside Design Guide* (AASHTO 2011b), only a few states have developed their own guidelines specifying their own criteria regarding pole-placement offset. Only a few STAs have utility placement guidelines that give specific consideration to siting poles with an understanding of trying to minimize crash risk. A few STAs offer additional guidance, such as minimum pole offset distances from the road in urban areas (e.g., 5 feet from the road) and in rural areas (e.g., 10 feet from the road), or simply avoid situating poles in high-risk areas, such as close to the road on the outside of horizontal curves, at the top of a T-intersection, at a lane drop, or in a median or traffic island.

## Exceptions to Pole-Placement Guidelines

Many STAs indicated that, in practice, an exception protocol for the established clear zone requirements is sometimes necessary. Several agencies reported that pole-placement exceptions were determined during the design process, before giving permission to UOs to install poles. Some of the most common answers regarding exception policies noted that pole removal would be too costly or would impose an extreme hardship. Another common basis for granting an exception stemmed from situations of inadequate right-of-way or topography that would not allow a safe installation (e.g., steep slopes). Another response noted that an exception would likely be granted to a UO if the exception does not pose a safety concern and is in the best interest of the UO and the state DOT. At least one STA stated that it would not allow poles to be located within the clear zone under any circumstances. Several STAs observed that exceptions are determined "on a case-by-case basis," and some indicated that poles may need to be moved outside of the right-of-way if they are too close to the road. Another STA reported that exceptions are rarely granted because all pole placements must meet AASHTO clear zone requirements.

## Utility Pole Crashes

All but 7 of the 46 states responding to the survey had the capability to identify whether a police officer coded a utility pole as the type of object struck for a specific crash. However, when asked about the total number of utility pole crashes for a given year, most states either could not produce this information or made a special request to the crash analysis unit to obtain the data. The survey also found that reporting on the number of utility pole nonfatal crashes is inconsistent from state to state because of different crash reporting thresholds and because some states combine utility poles and light poles under one category on crash reporting forms.

Based on survey responses, a reasonable conclusion is that some states do have information on utility pole high-crash sites, usually gathered when they conduct a site-by-site investigation of locations with a high number of crashes and sometimes when they select countermeasures (such as guardrail installation) to address the crash problem. Interestingly, of the 887 fatal utility (plus light) pole crashes in the United States in 2017, more than half of these fatalities (465) occurred in 10 of the 50 states (NHTSA 2018):

- Florida (84)
- Texas (69)
- California (57)
- Pennsylvania (56)
- Tennessee (42)
- North Carolina (38)
- Illinois (36)
- New York (28)
- Georgia (28)
- Indiana (27).

Of course, these 10 states also rank among the states with the largest populations and the highest total miles driven.

## Tracking High-Risk Poles

Only four states indicated that their STAs routinely track locations with a high number of utility pole crashes. A few states noted that they have computer capabilities (such as mapping tools and computer databases) that enable them to conduct searches to identify sites that experience high numbers of utility pole crashes. Several other STAs reported that they did not specifically track utility poles with a history of vehicle collisions, but they explained how utility poles with a history of being struck might be determined through another process. For example, if a site or roadway section is identified as at high risk of crashes, the STA reviews crashes in that section in more detail and evaluates them to assess the possible effectiveness of pole-related countermeasures.

## Identifying High-Risk Poles

Of the 46 participating STAs, 14 noted that they had a process in place to identify high-risk poles based on their placement and before they were struck. Examples of such sites include poles at lane drops, at intersections, close to the outside of horizontal curves, and too close to the road at other locations, especially on high-volume roads. In addition, STA responses indicated the following types of poles that would be detected:

- 11 STAs: poles in the clear zone or too close to the roadway
- 8 STAs: poles outside of a horizontal curve
- 6 STAs: poles at or near an intersection
- 6 STAs: poles at or near a lane drop (as part of the process to identify poles in high-risk locations).

## Countermeasures in Use

The selection and implementation of safety measures to address locations experiencing utility pole crashes typically are the responsibility of the traffic engineering or safety engineering office of an STA. Of the 46 responding states, the countermeasures most often cited as options for treating utility pole safety problems were as follows:

- Guardrails or guiderails (31 states)
- Crash-attenuation barrels (10 states)
- Shoulder widening or paving (15 states)
- Rumble strips (19 states)
- Pole-visibility features (25 states)
- Steel-reinforced safety poles (7 states)
- Underground utility lines (23 states)
- Shared utility agreements (21 states).

New Jersey mentioned that it uses fiberglass poles in certain situations because they shatter on impact from a motor vehicle, resulting in a lower risk of severe injury to vehicle occupants when compared to steel and wooden poles.

## Funding

Improvements for utility pole safety can be funded by various federal, state, local, and other sources of financing. A total of 32 STAs confirmed using federal funds, and 17 of those states specifically cited HSIP funding. In addition, 25 STAs noted state funding as part of their safety improvement resources; such sources included SHSP, matching, state maintenance, spot safety improvement, and state safety funds. Nine STAs employed local financing as a partial match for certain projects. Four STAs reported using "other funds" for relocating utility poles.

## Local and Utility Owner Policies

Of the 46 STAs that participated in the survey, 35 STAs answered that they knew of no local agencies or utility providers that have developed their own utility pole safety policies. Nine STAs mentioned local agencies that may have developed their own guidelines. One STA respondent stated, "Some cities and counties have changed policies to only allow underground facilities." Six STAs were aware of UOs that have developed their own safety programs or guidelines.

## Factors Related to Utility Pole Crashes

An extensive number of research studies have been conducted since the 1970s on utility pole crash factors and potential countermeasures, but the amount of research on this topic has diminished in recent years. Some of the roadway and pole factors documented by research as related to a higher frequency of utility pole crashes are higher volume of vehicular traffic (AADT), larger number of poles per mile within the highway right-of-way, closer pole offset (i.e., narrower buffer between the pole and the roadway), more roadway curvature (i.e., sharper horizontal curves or steeper vertical grades), lower pavement skid resistance, and lack of proper curve superelevation. The location of a pole at high-risk spots (such as at an intersection, at or near a lane drop, or directly outside of a horizontal curve) also increased the chance of a collision with a utility pole.

Research has found that approximately 50% of utility pole crashes result in at least one person being injured, with 1% to 2% of crashes causing a fatality. A greater chance of death or serious injury from a utility pole collision was associated with higher impact speeds, greater pole circumference, and certain pole types. Specifically, impacts with wooden poles were usually more severe than collisions with metal poles, but the metal poles used in the research typically incorporated some type of breakaway or frangible base, installed to reduce the severity of a vehicle impact.

Crashes along roadway sections typically are categorized as more severe than those at intersections, likely the consequence of lower vehicle speeds at intersections. Vehicle and occupant factors associated with more severe outcomes include certain vehicle characteristics (e.g., smaller vehicles), impact configuration (i.e., side impacts, which are more severe than head-on collisions), and failure of occupants to use restraints.

## Utility Poles at High-Risk Locations

A utility pole in a high-risk site is one in a location within the roadway environment where the pole carries an above-average risk of being struck by an errant motorist and where serious injury or death is a likely outcome of such a collision. Estimates have indicated that no more than 1/10 of 1% (0.001) of existing poles nationwide are in such high-risk sites. In other words, utility pole safety could be greatly enhanced across the country by addressing this small percentage of high-risk poles. Examples of high-risk locations include those with poles that are close to intersections, on the outside of horizontal curves (and close to the road), immediately after (and in line with) a lane drop, in the roadway median or traffic island, and adjacent to reverse curves. Utility poles in these types of sites are considered to be in high-risk locations and are typically identified as needing safety measures.

## Cost-Effectiveness Treatments

On the basis of their research from the 1980s, Zegeer and Parker (1983) created a utility pole crash-prediction model based on traffic volume (ADT), pole density, and pole offset from the road. This crash-prediction model led to the development of estimated crash effects (CMFs) for countermeasures such as moving poles further from the road (i.e., pole relocation), reducing the number of poles within a roadway section (i.e., increased pole spacing), arranging multiple-use poles (i.e., removing a line of poles on one side of the road and doubling up lines on poles on the other side), burying utility lines underground (combined with pole removal), and using breakaway poles. Based on the CMF values, cost of countermeasures, and human and financial costs of various pole-related crashes, cost-effectiveness charts and tables were reported, similar to those developed in the study by Zegeer and Parker (1983).

The factors related to expected crashes and countermeasure effectiveness included ADT, pole density, and pole offset. In addition, other factors included a measure of other roadside features (termed a roadside rating) that affect how many crashes might still occur if a pole is removed, repositioned, or altered and the type of pole (telephone, electric, one-phase or three-phase, transmission pole). Most of the specific pole-related treatments (e.g., pole relocation, underground lines, multiple-use poles, breakaway poles) were calculated to be cost-effective (with a benefit-cost ratio greater than 1) for most roadway situations, particularly where the utility poles are currently within about 5 or 10 feet from the roadway and the traffic volume is moderate or higher (e.g., 10,000 ADT vehicles). This assessment was particularly valid for relocating poles (from 5 feet or closer to at least 20 feet from the road) and for burying utility lines underground (with pole removal). Multiple-use poles (running lines on only one side of the road) were often cost-effective, but reducing pole density simply by increasing pole spacing was rarely cost-effective.

Treatments involving telephone poles were far less costly than those for poles carrying electric lines and therefore mathematically more likely to be cost-effective compared to similar treatments for larger electric transmission poles and lines. The use of breakaway devices on poles was thought to probably be cost-effective for individual poles in high-risk locations although CMFs for this treatment were only estimates and not as well known. Because of the large size of transmission poles and the associated costs for moving them, none of the countermeasures that repositioned these poles or lines was calculated as cost-effective. In such instances, guardrails or crash-attenuation devices would generally be much more advisable and more likely to be cost-effective.

The previous cost-effectiveness discussions should be read with caution because the costs of both crashes and countermeasures have increased since the referenced Zegeer and Parker (1983) study. An analyst could employ the same CMF values as reported herein, with more up-to-date costs for crashes and countermeasures, to compare the benefit-cost ratio of treatment options for a specific case.

## STA and UO Utility Pole Treatment Options

Many practical solutions and countermeasures are available to address utility poles in high-risk locations, including those summarized in this section.

UO treatment options include removing poles, repositioning poles to less high-risk locations, or both; decreasing the number of poles through multiple-use poles or expanded pole spacing; increasing lateral pole distance from the pavement travel way; and burying utility lines underground.

STAs can implement some measures to keep vehicles on the roadway and away from poles, such as pavement markings, signs and roadway lighting, pavement delineation measures (e.g., edge-line paint stripes and raised pavement markers), edge-line rumble strips, improved pavement skid resistance, wider lanes, wider and paved shoulders, enhanced curve safety (e.g., improved superelevation, additional in-advance curve warning and chevron signs, straighter curves), additional pavement skid treatments, and other less common techniques.

STAs can also use safety devices to reduce the severity of crashes when vehicles do leave the roadway. Such devices include composite yielding poles, steel-reinforced safety poles, crash cushions, concrete barriers, guardrails and crashworthy guardrail terminal ends, breakaway guy wires, buried duct networks for utility cables, and other less frequently used methods.

## Example of a Logical Approach to a Utility Pole Safety Program

TRB State of the Art Report 9 explains an approach for reducing utility pole-related fatalities and serious injuries, as developed and described by Ivey and Scott (2004). This plan includes the following strategic approach options:

- **Best Offense**. This approach identifies where an atypically high number of collisions are occurring, assesses available countermeasures, prioritizes these high-risk poles for treatment, and implements the improvements.
- **Best Bet**. This approach prioritizes potentially hazardous poles and roadway sections, possibly using statistical prediction algorithms, before a crash history develops and also implements appropriate improvements.
- **Best Defense**. This approach complements the first two strategies and entails striving to meet the recommendations of the *Roadside Design Guide* (AASHTO 2011b) and Ivey and Scott (2004).

## Examples of Utility Pole Safety Initiatives

Based on information in the literature and in survey responses, several STAs and UOs were selected for development of more detailed case studies. The STAs include Washington State, New Jersey, Georgia, and North Carolina. In addition, one anonymous STA is discussed in a case example because its utility pole safety program was scaled back in recent years in response to challenges that the STA faced in dealing with UOs in the state. This case example is included with the thought that other STAs might relate to similar challenges and develop their own tailored approaches to address them. To protect their privacy, four unnamed UOs were selected to provide documentation of their utility pole safety practices and policies. Appendix F cites an Ivey and Scott (2004) appendix where Scott describes a recommended utility pole crash-reduction program for STAs. Appendix G details specific STA utility pole safety guidance from several states.

## Implications of Synthesis

Much was learned from the literature review and from the STA survey responses. Specifically, only a few (less than half) of the STAs have policies or guidelines that focus on utility pole placement going beyond the AASHTO Green Book (2011a) and *Roadside Design Guide* (2011b) and that also appear to actively identify and treat utility pole safety problems.

Part of the challenge with STAs is diffuse authority: safety issues related to utility poles were under the jurisdiction of at least three different departments in most STAs or transportation departments. Specifically, each state delegated the task to a department that handles utility accommodation and works with the UOs in the state to apply pole-placement guidelines. STAs usually have a separate transportation or safety engineering office that holds responsibility for identifying high-crash and high-risk locations and for conducting engineering studies to select countermeasures to reduce the risk of potential crashes. During this process, safety engineers normally review all types of crashes and highway risks (at least annually) but usually review utility pole crashes only if they represent a cluster of crashes at a previously identified high-crash or high-risk location.

In addition, in most STAs, another office typically produces crash summaries and conveys crash trends and high-crash location information to the safety engineers. This safety engineering data office may also secure funding for implementing recommended treatments. Most of the STA engineers interviewed did not know offhand the number of utility pole crashes in their state for 2016. Some STAs made a special request for another department to conduct a data search just to obtain that information for this synthesis survey. Thus, different offices within a given STA managed the problem of utility pole safety in many cases. However, as many as 20 STAs did have some utility pole safety policies and procedures, including pole-placement guidelines, processes to identify and treat poles in high-risk locations, or both. Many states use countermeasures such as installing guardrails, edge-line rumble strips, low concrete barriers, and other barrier types to address roadside safety problems, which may include utility pole crash issues.

Based on the interaction with STAs during this synthesis report process, less than a dozen undertook ongoing systematic utility pole safety activities. Very few UOs had at least adopted guidelines to consider removing poles in high-risk locations, although steel-reinforced safety (breakaway) poles are employed in about six states, according to STA contacts. In addition to being governed by STA pole accommodation guidelines in each state, UOs are also routinely subject to the provisions of the *National Electrical Safety Code* (Institute of Electrical and Electronic Engineers 2017), which designates that UOs site poles a minimum of 18 inches from the edge of curb. However, safety research has indicated that an offset distance of approximately 10 feet (compared to siting poles approximately 2 feet from the roadway edge) is needed to reduce a great majority (up to 70 to 80%) of utility pole crashes.

In short, during the roughly 15 years since TRB State of the Art Report 9 (Ivey and Scott 2004) was published, neither the STAs nor the UOs appear to be making much progress toward improving practices for utility pole safety. Most STAs still do not have routine procedures to specifically identify locations with clusters of utility pole crashes, nor do most of the states categorize utility poles in high-risk sites. In one case example (for the anonymous STA), some very proactive policies addressed utility pole safety as recently as 2004, but those policies had been largely excised from more recent editions of the state's utility manual because of challenges in implementing those procedures.

Utility poles stand as the rigid obstacle that our society in general recognizes but only a few STAs have addressed systematically, even with a long-term goal of reducing highway fatalities and severe injuries. The *Roadside Design Guide* (AASHTO 2011b) observes that through decades of safety research and experience, the application of the "forgiving roadside" concept has been refined to the point where roadside design constitutes an integral part of the transportation design process. AASHTO consistently has recommended the following hierarchy for reducing roadside obstacles:

1. Remove the obstacle
2. Redesign the obstacle so that it can be safely traversed
3. Relocate the obstacle to a point where it is less likely to be struck
4. Reduce the impact severity by using an appropriate breakaway device
5. Shield the obstacle with a longitudinal traffic barrier designed for redirection (or use a crash cushion)
6. If the previous alternatives are not appropriate, delineate the obstacle.

For every utility pole that is documented as occupying a high-risk location, at least one and usually several of these listed options are reasonable solutions to achieve the objective of a forgiving roadside. If the hazardously located utility poles in the nation are not moved or addressed with countermeasures known to improve safety, a historical total of 100,000 utility pole-related fatalities and an estimated 3 million injuries may be reached by yearend 2020 or shortly thereafter.

## Current Gaps in Knowledge

Based on the review of literature and input from STA surveys, an understanding of the gaps in current knowledge sharpened. For example, gaps exist on the current economic analysis metrics for various treatment options that can improve the safety of individual utility poles or a line of poles along a highway. In particular, no known published information addresses the current costs for pole relocation, multiple-use poles, underground lines, increased pole spacing, and installation of breakaway poles (e.g., fiberglass poles, steel-reinforced safety poles) for different types of utility lines and poles (e.g., telephone versus electric versus transmission poles). Also, crash effects (CMFs) should be updated for these treatments and for STA treatments such as guardrails, cash attenuators, and shoulder improvements. Similarly, CMFs for horizontal curve and intersection countermeasures to improve utility pole safety must be better quantified. Such current information is necessary to support updating the benefit-cost analysis from the Zegeer and Parker (1983) study.

In addition, very little is known concerning the safety of various other types of poles, such as traffic signal support poles and buddy poles (two poles installed close together for added support that may cause a more severe crash outcome when struck). Furthermore, actions should be identified that can contribute to agencies acquiring a better understanding of utility pole safety issues that will lead to positive change.

## Future Research Areas

Based on these gaps in knowledge on utility pole safety, several potential research areas are identified, most notably the following:

1. Updated information should be gathered on countermeasure installation costs and annual maintenance costs for relocating poles, reducing pole density (i.e., installing multiple-use poles, increasing pole spacing in hazardous locations), running utility lines underground, and using breakaway poles (i.e., fiberglass and steel-reinforced safety poles). This information collection should be performed for all types of utility poles and lines, including telephone poles and various levels of electric distribution poles and lines. Updated benefit-cost ratios for implementing various pole-related treatments should be developed based on these updated countermeasure costs, annual maintenance costs, and up-to-date costs for utility pole crashes.
2. A formal evaluation of steel-reinforced safety poles, fiberglass yielding poles, and other yielding utility poles would be useful. Regarding steel-reinforced safety (breakaway) poles, FHWA previously managed a demonstration project that paid for the cost of retrofitting selected utility poles in high-risk locations. That initiative led to four states participating in the project. As a result, the selected utility poles were converted to breakaway features. A similar demonstration, only with a provision for other breakaway pole designs (such as the fiberglass yielding poles), was conducted in New Jersey, and more information on other comparable designs would be informative. Moreover, various types of barriers, barrier end treatments, and similar devices could be evaluated as part of this effort. Recommendations would be helpful regarding the feasibility and effectiveness of various types of countermeasures when used to treat high-risk poles that cannot easily be moved or removed.
3. One helpful study could identify the factors and conditions that led some STAs and UOs to recognize the importance of addressing utility pole safety problems—as well as the measures that might be effective in convincing other agencies to more aggressively implement policies and practices to improve utility pole safety. An analysis should be performed on how dedicated funding could be made available to STAs, LPAs, and UOs for expenditures on safety improvements related to roadside and utility pole safety.

4. Model policies should be developed for STAs and UOs that go beyond the guidance in the AASHTO Green Book (AASHTO 2011a) and the *Roadside Design Guide* (AASHTO 2011b) and are suited to the specific safety needs of each jurisdiction. The guidance could consider current knowledge based on roadside safety literature with respect to the crash risks associated with various pole offsets from the curb (urban areas) and from the roadway edge (rural areas). The guidance could also incorporate updated data about the types of high-risk locations, including risks at lane drops, in medians and traffic islands, at horizontal curves, and at intersections, among others.
5. Research should define and document the various methods that safety officials can employ to track utility pole crashes in an STA and an LPA. Methods could also be documented for the identification of high-risk poles based on location in the highway environment. This study could result in recommendations to STAs and LPAs on how to implement such procedures to identify not only high-crash but also high-risk utility poles. Case studies of STAs that currently use these procedures could also be helpful.
6. A study would be useful regarding box-span signals at high-risk intersections and their crash history. The relative safety of other roadside obstacles could also be studied, including buddy poles—two poles installed close together for added support that may cause a more severe crash if struck by a motor vehicle. Potential countermeasures could be developed to improve the safety of such objects.

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# Glossary

The definitions of most of the following terms are taken directly from (1) the American Association of State Highway and Transportation Officials (AASHTO) October 2005 publication *A Policy on the Accommodation of Utilities within Freeway Right-of-Way* (AASHTO 2005b); and (2) the AASHTO 2011 *Roadside Design Guide*, 4th Edition (AASHTO 2011b).

**Accident**: A term used in older (early) highway safety literature to refer to either (1) a crash or collision between a motor vehicle and another vehicle, a person (i.e., a pedestrian or bicyclist), or a fixed object (e.g., a tree or utility pole); or (2) a vehicle that runs off of the road and rolls over.

**Arterial Highway**: A general term denoting a highway primarily for through traffic, usually on a continual route.

**Average Annual Daily Traffic (AADT), also known as Average Daily Traffic (ADT)**: The number of motor vehicles that travel along a roadway on an average day throughout the year. The AADT value is often computed (estimated) based on applying an adjustment factor to a short-term traffic count. The adjustment factor is based on the particular day of the week, season of the year, and similar considerations.

**Barrier**: A device that provides a physical limitation through which a vehicle would not normally pass. The barrier is intended to contain or redirect errant vehicles.

**Breakaway**: A design feature that allows a device such as a sign, luminaire, or traffic signal support to yield or separate upon impact. The release mechanism can be a slip plane, plastic hinges, fracture elements, or a combination of these.

**Clear Zone**: The total roadside border area, starting at the edge of the travel way, that is available for safe use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a nonrecoverable slope, and/or a clear run-out area. The desired width is dependent on the traffic volumes and speeds and on the roadside geometry.

**Clearance**: The lateral distance from the edge of the traveled way to a roadside object or feature.

**Control of Access**: The condition where the right of owners or occupants of abutting land (or other persons) to access, light, air, or view in connection with a highway is fully or partially controlled by public authority.

**Cost-Effective**: An item or action taken that is economical in terms of the tangible benefits produced for the money spent.

**Expressway**: A divided arterial highway for through traffic, with partial control of access and generally with grade separations at major intersections.

**Freeway**: A controlled-access divided arterial highway with grade separations at intersections.

**Full Control of Access**: Authority to control access that is exercised to give preference to through traffic by providing access connections with selected public roads only and by prohibiting crossings at grade or direct private driveway connections.

**High-Risk Utility Pole**: A utility pole that is placed in a location in the roadway environment where there is an above-average risk of it being struck by an errantly controlled vehicle and where serious injury or death is a possible outcome of such a collision.

**Highway, Street, or Road**: A general term denoting a public way for the transportation of people, materials, goods, and services but primarily for vehicular travel, including the entire area within the right-of-way.

**Longitudinal Barrier**: A barrier whose primary function is to prevent penetration and to safely redirect an errant vehicle away from a roadside or median obstacle.

**Luminaire**: A pole that carries overhead lighting and is usually made of metal. Some luminary devices are placed on utility poles, which are usually wood.

**Median**: The portion of a divided highway separating the traveled ways for traffic that moves in opposite directions.

**Metal Utility Pole**: A metal pole that carries utility lines, such as telephone, electric, or cable lines. These poles are rare because most utility lines are carried on wooden poles.

**Partial Control of Access**: Authority to control access that is exercised to give preference to through traffic to a degree that, in addition to access connections with selected public roads, some crossings at grade and some private driveway connections may be allowed.

**Permit**: The written agreement by which the transportation agency approves the use and occupancy of a highway right-of-way by utility facilities or private lines. A permit is also called an occupancy agreement.

**Private Lines**: Privately owned facilities that convey or transmit the commodities outlined in the definition of utility facilities but are devoted exclusively to private use.

**Right-of-Way (ROW)**: A general term denoting land, property, or interest therein, usually in a strip acquired for, or devoted to, transportation purposes.

**Roadside**: A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be termed roadsides.

**Roadside Crash Cushions:** Reusable crash cushions with some major components that may be capable of surviving most impacts intact. Such components can be salvaged when the roadside crash cushion unit is being repaired.

**Roadway**: The portion of a highway, including shoulders, for vehicular use. A divided highway has two or more roadways.

**Temporary Barrier**: Temporary devices that are used to prevent vehicular access into construction or maintenance work zones and to redirect an impacting vehicle, thereby minimizing damage to the vehicle and injury to the occupants while providing worker protection.

**Traffic Barrier**: A device used either (1) to prevent a vehicle from striking a more severe obstacle or feature located on the roadside or in the median or (2) to prevent crossover median crashes. As defined herein, there are four classes of traffic barriers, namely roadside median barriers, bridge barriers, railings, and crash cushions.

**Transportation Agency**: The department, agency, commission, board, or official of any state (or political subdivision thereof) charged by its law with the responsibility for highway administration.

**Traveled Way**: The portion of the roadway for the movement of through traffic.

**Utility Accommodation Policy**: A statement of the policies and procedures used by a transportation agency to regulate and accommodate utilities on the highway right-of-way.

**Utility Facility**: A privately, publicly, or cooperatively owned line, facility, or system for producing, transmitting, or distributing communications, cable, heat, gas, oil, crude products, water, streams, waste, storm water not connected with highway drainage, or any other similar commodity, including any fire or police signal system or street lighting system that directly or indirectly serves the public.

**Utility Pole Crash**: A traffic collision that involves a motor vehicle striking a utility pole. This term is consistent with other terms that safety researchers use to describe crash types. For example, pedestrian crashes, bicycle crashes, and mailbox crashes are defined as vehicles striking such people or objects.

**Yielding Utility Pole**: An energy-dissipating pole that is designed to bend or break upon impact from a motor vehicle.

# Abbreviations

| | |
|---|---|
| AADT | Average annual daily traffic |
| AA&P | Accident Analysis and Prevention |
| ADA | Americans with Disabilities Act |
| ADT | Average daily traffic |
| ARF | Accident reduction factor |
| CFR | Code of Federal Regulations |
| CMF | Crash modification factors |
| DMV | Department of motor vehicles |
| FARS | Fatality Analysis Reporting System |
| GUCC | Georgia Utilities Coordinating Council |
| HBS | Hawkins Breakaway System |
| HSIP | Highway Safety Improvement Program |
| IEEE | Institute of Electrical and Electronic Engineers |
| IIHS | Insurance Institute for Highway Safety |
| LPA | Local public agencies |
| MASH | Manual for Assessing Safety Hardware |
| NASS | National Accident Sampling System |
| NHTSA | National Highway Traffic Safety Administration |
| NHUC | National Highway Utilities Conference |
| NTSB | National Transportation Safety Board |
| PDO | Property damage only |
| RAF | Roadside adjustment factor |
| RDG | Roadside Design Guide |
| ROW | Right-of-way |
| RRR | Resurfacing, restoration, and rehabilitation |
| RSAP-V3 | Version 3 of the Roadside Safety Analysis Program |
| RSP | Roadside safety program |
| SHSP | Strategic Highway Safety Program |
| SPF | Safety performance function |
| STA | State transportation agencies |
| TL | Test Level |
| UO | Utility owners |
| UPMP | Utility Pole Mitigation Program |

APPENDIX A

# State DOT Utility-Related Websites, 2019

| STATE | UTILITY ACCOMMODATION POLICY |
| --- | --- |
| Alabama | ALDOT Utilities Manual: https://www.dot.state.al.us/rwweb/util/utilitiesgrid/UtilitiesManual.pdf |
| Alaska | Http://www.dot.state.ak.us/stwddes/dcsprecon/preconmanual.shtml |
| Arizona | Guideline for Accommodating Utilities on Highway Rights-of-Way: https://www.azdot.gov/docs/default-source/utility-and-railroad-engineeing/urr-accommodationg-guideline_august-2015.pdf?sfvrsn=4 |
| Arkansas | Utility Accommodation Policy (2010): http://www.arkansashighways.com/right_of_way_division/Utility%20Accommodation%20Policy%20effective%201-1-2012.pdf<br><br>A relocation process is contained in the Arkansas Utility Accommodation Policy. |
| California | Utility Relocation: http://www.dot.ca.gov/hq/LocalPrograms/lam/LAPM/ch14.pdf<br>Encroachments and Utility Placement: http://www.dot.ca.gov/design/manuals/pdpm/chapter/chapt17.pdf<br>From STA: http://www.dot.ca.gov/design/manuals/pdpm/chapter/chapt17.pdf<br>Highway Design Manual, Topic 309: http://www.dot.ca.gov/design/manuals/hdm/chp0300.pdf |
| Colorado | Utility Accommodation Code (2009): https://www.sos.state.co.us/CCR/GenerateRulePdf.do?ruleVersionId=3222<br>From STA: State Highway Utility Accommodation Code: https://www.sos.state.co.us/CCR/GenerateRulePdf.do?ruleVersionId=3222 |
| Connecticut | Utility Accommodation Manual (2009): http://www.ct.gov/dot/lib/dot/documents/dutilities/ACCOMODATION.pdf |

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| Delaware | Utilities Accommodation Manual: http://regulations.delaware.gov/AdminCode/title2/2000/2400/2401.shtml |
| District of Columbia | N/A |
| Florida | Utility Accommodation Manual: https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/programmanagement/programmanagement/utilities/docs/uam/uam2010.pdf?sfvrsn=aa21558a_0 |
| Georgia | Utility Accommodation Policy and Standards Manual (2016): http://www.dot.ga.gov/PartnerSmart/utilities/Documents/2016_UAM.pdf |
| Hawaii | Scanned Document on Utility Accommodation: http://hidot.hawaii.gov/highways/files/2012/12/HAR19-105.pdf Entire Electronic Document: http://hidot.hawaii.gov/highways/files/2017/12/AG-135-HAR-Mod-draft-10-20-17.pdf |
| Idaho | Guide for Utility Management: https://apps.itd.idaho.gov/apps/manuals/UtilityMgmt/GUM.pdf |
| Illinois | Accommodation of Utilities on Right-of-Way Rule, Title 92: http://www.ilga.gov/commission/jcar/admincode/092/09200530sections.html |
| Indiana | Utility Accommodation Policy (2014): http://www.in.gov/indot/files/UC_UtilityAccommodationPolicy_061214.pdf |
| Iowa | Policy for Accommodating and Adjustment of Utilities on the Primary Road System: https://iowadot.gov/rightofway/pdfs/UtilityPolicy.pdf |
| Kansas | Utility Accommodation Policy: https://www.ksdot.org/Assets/wwwksdotorg/bureaus/burConsMain/Connections/UAP2007_2016_aug.pdf.pdf |
| Kentucky | Utilities and Rails Guidance Manual: https://transportation.ky.gov/Organizational-Resources/Policy%20Manuals%20Library/Utilities%20and%20Rails.pdf |
| Louisiana | Title 70, Transportation; Part II, Utilities; Chapter 5: http://wwwsp.dotd.la.gov/Inside_LaDOTD/Divisions/Engineering/Roa |

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| | d_Design/UtilitiesRelocation/Documents/Title_70_-_Part_II_Utilities.pdf<br><br>http://wwwsp.dotd.la.gov/Government/Misc%20Documents/Louisiana%20Administrative%20Code%20Title%2070.pdf?Mobile=1&Source=%2FGovernment%2F_layouts%2Fmobile%2Fview.aspx%3FList%3D7fbb726a-d8f1-45aa-b043-dbd89d6e20ac%26View%3D49d9d8f3-d10b-4a5e-afac-2360ac09b094%26CurrentPage%3D1 |
| Maine | Utility Accommodation Policy:<br>https://www1.maine.gov/mdot/utilities/docs/FINAL2014UtilAcmdnRules.pdf |
| Maryland | Utility Policy:<br>https://www.roads.maryland.gov/OOC/Utility_Policy.pdf<br>Utility Procedure Manual:<br>https://www.roads.maryland.gov/OOC/Utility-Procedures-Manual%20_98_.pdf |
| Massachusetts | Utility Accommodation Policy on State Highway Right of Way (2013):<br>https://www.mass.gov/files/documents/2017/10/24/UAP.pdf |
| Michigan | Road Design Manual:<br>https://mdotcf.state.mi.us/public/design/englishroadmanual/<br>Utility Accommodation Policy:<br>https://www.michigan.gov/documents/mdot/3-31-2011_UTILITY_ACCOMMODATION_POLICY_635432_7.pdf |
| Minnesota | Utility Accommodation & Coordination Manual (2016):<br>http://www.dot.state.mn.us/utility/projectdelivery.html<br>Click on link in first section entitled "Utility Coordination Process." |
| Mississippi | The Accommodation of Utilities on Freeway Rights of Way:<br>http://mdot.ms.gov/apa_data/apa_rules/PDF_Record/maintenance/941-7501-06001/941-7501-06001.pdf |
| Missouri | Utility Procedures:<br>http://epg.modot.org/index.php/Category:643_Utility_Procedures |
| Montana | Guidelines for Utility Occupancy on Highway Right of Way:<br>https://www.mdt.mt.gov/other/webdata/external/ROW/manual/chapter_43.pdf |
| Nebraska | Policy for Accommodating Utilities on State Highway Right-of-Way:<br>https://dot.nebraska.gov/media/6872/utilaccom.pdf |
| Nevada | Right of Way Manual:<br>https://www.nevadadot.com/home/showdocument?id=4492<br>Accommodating Utilities Within Highway Right of Way:<br>https://law.resource.org/pub/us/cfr/ibr/001/aashto.utilities.2005.pdf |
| New Hampshire | Utility Accommodation Manual:<br>http://www.nh.gov/dot/org/projectdevelopment/highwaydesign/documents/UAM_complete.pdf |

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| New Jersey | Administrative Code, Title 16, Chapter 25: Utility Accommodation: http://www.lexisnexis.com/hottopics/njcode/ Utility Accommodation: https://www.state.nj.us/transportation/about/rules/documents/16-25-Current.pdf |
| New Mexico | Requirements for Occupancy of State Highway System Right-of-Way by Utility Facilities: http://164.64.110.134/parts/title17/17.004.0002.pdf |
| New York | Part 131 of NYSDOT Rules & Regulations, NYCRR Title 17, Accommodation of Utilities within State Highway Right-of-Way: https://www.dot.ny.gov/divisions/engineering/design/dqab/util-info Click on link to Part 131. |
| North Carolina | Utility Policy Manual (2014): https://connect.ncdot.gov/municipalities/Utilities/UtilitiesDocuments/Utilities%20Policy%20Manual.pdf |
| North Dakota | A Policy for Accommodation of Utilities on State Highway Right of Way (2006): http://www.dot.nd.gov/manuals/environmental/policy-utilities-state-row.pdf |
| Ohio | Policy for Accommodation of Utilities: http://www.dot.state.oh.us/districts/D10/d10planning/Right_of_Way_Permits/Documents/Manuals/Utilities%20Manual.pdf |
| Oklahoma | Specifications Manual for Right-of-Way Plans and Associated Materials: http://www.okladot.state.ok.us/rowconsult/mapping/_revised_specs/Specifications%20Manual%20for%20ROW%20Plans%202009.pdf |
| Oregon | Utility Accommodation Policy (OAR 734-055) (2015): http://arcweb.sos.state.or.us/pages/rules/oars_700/oar_734/734_055.html Utility Relocation Manual: https://www.oregon.gov/ODOT/ROW/Docs_Utilities/Utility-Relocation-Manual.pdf |
| Pennsylvania | Utility Relocation: https://www.dot.state.pa.us/public/pubsforms/Publications/PUB%2016M/PUB%2016M.pdf |
| Puerto Rico | N/A |
| Rhode Island | Rules and Regulations for Accommodating Utility Facilities within Public Freeway Rights-of-Way: https://risos-apa-production-public.s3.amazonaws.com/DOT/DOT_1302_.pdf |
| South Carolina | Utilities Accommodation Manual (2011): https://www.scdot.org/business/pdf/rightofway/ua_policy.pdf |
| South Dakota | Accommodation of Utilities on County Highway Right-of-Way: https://lincolncountysd.org/userfiles/file/Highway/LincolnCountyUtilityPermitingPolicyGuidelines.pdf |

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| Tennessee | Rules and Regulations for Accommodating Utilities within Highway Rights-of-Way (2003): https://publications.tnsosfiles.com/rules/1680/1680-06/1680-06-01.pdf Utility Manual (2018): https://www.tn.gov/content/dam/tn/tdot/right-of-way-division/utility-documents/Utility_Proceedures_Manual.pdf |
| Texas | Texas Administrative Code, Utility Accommodation: https://texreg.sos.state.tx.us/public/readtac$ext.ViewTAC?tac_view=4&ti=43&pt=1&ch=21 |
| Utah | Utility Accommodation Rule, Administrative Rule 930-7 (2012): http://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:4080, |
| Vermont | Utility Accommodation Plan: https://vtrans.vermont.gov/sites/aot/files/highway/documents/rightofway/UAP%20Final%20March%202016.pdf |
| Virginia | Utility Manual of Instructions, Utility Relocation Policies & Procedures (2014): http://www.vdot.virginia.gov/business/resources/Right_of_way/Utility_Manual10012014.pdf<br><br>Information about VDOT's Utility Accommodation Policy is contained in Chapter 8, Section 8.3, of the above manual. |
| West Virginia | Accommodation of Utilities on Highway Right of Way and Adjustment and Relocation of Utility Facilities on Highway Projects (2007): http://www.transportation.wv.gov/highways/engineering/files/ACCOMMODATION_OF_UTILITIES.pdf Both utility accommodation information and utility coordination information are contained in the above manual. |
| Wisconsin | Utility Accommodation Policy (2015): http://www.dot.wisconsin.gov/business/rules/property-uap.htm |
| Wyoming | Utility Accommodation Regulation (1990): http://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Highway_Development/Utilities/WYDOT%20Utility%20Accommodation%20Regulations_Jan%202017.pdf |

APPENDIX B

# Summary of Survey Results

The synthesis survey was designed to gather the best information regarding current STA practices on addressing utility pole safety. The team intentionally chose to include nine questions (nine plus contact information) in order to maximize the response rate and also obtain the most useful responses from the survey. The Project Team anticipated a greater participation rate by STAs through ensuring that the survey represented a minor time commitment to STA recipients. It was decided that 10 questions would be the optimal number of questions that would also allow for the necessary data to be collected. Survey Monkey was initially selected as the survey platform to be used due to its ease of use and the fact that it was a well-known and trusted survey platform.

Of the 50 STAs invited to participate in the Survey Monkey platform, approximately 25% initially responded. Eleven STAs completed the survey with a 92% completion rate. Two STAs returned the survey with no responses (i.e., opted out of taking the survey).

Two additional STAs contacted the Project Team (via email) with concerns over the authenticity of the survey. Both of these STA contacts informed the Project Team that (despite the content of the cover letter that included a description and explanation of the purpose of the survey as well as contact information for the project manager and the associated TRB contract administrator) they would not be able to participate in the survey as it was on the Survey Monkey platform. Both of these STA survey recipients informed the Project Team that they were discouraged by their department from opening emails from unknown sources.

In consideration of this feedback and the low rate of responses on Survey Monkey, the decision was made by the Project Team to continue the surveying process by phone and email.

Early in the process of designing the survey, it was anticipated by the Project Team that the nine questions would be best suited for more than one contact within each department. The Project Team initially accounted for this factor in the language of the Survey Monkey cover letter, which asked the STA contact to distribute the survey questions to the personnel who were the most qualified to answer each individual question.

During the telephone and email surveying process, a very low number of STA representatives were able to answer all nine Project Team questions without deferring to another member within their department. Only two of those surveyed over the telephone were able to answer question number 5 regarding the number of utility pole crashes in their state in 2016.

To accommodate the general departmental organization of STAs, the Project Team divided the survey into three parts and targeted the best-suited recipient for each group of questions, based on their associated and perceived responsibilities or job title. The utility engineer for each STA was targeted for survey questions 2, 3, and 10, which dealt with utility pole placement guidelines. The data analyst was targeted for questions 4 and 5, which were questions asking about crash information within the STA.

The safety engineer was targeted for questions 6, 7, 8, and 9 because these questions asked about STA procedures for identifying pole-related crash locations and high-risk locations, countermeasure selection, and funding sources for countermeasures. The Project Team observed that only two of the STA survey participants who participated in telephone interviews were willing and able to provide answers to all of the survey questions. The note provided to potential respondents of the survey is provided below, in addition to the full survey.

## Note to Potential Respondents

Every year in the United States, there are an estimated 75,000 collisions, 30,000 serious injuries, and 1,000 deaths involving vehicles striking utility poles (i.e., one collision every 7 minutes). Roadway departure crashes account for more than 50 percent of the total traffic-related fatalities and serious injuries in the U.S., with utility poles representing the second largest group of fixed-object fatal crashes. (P. Scott and D. Ivey, “Utility Pole Crashes,” Transportation Research Board, January 2015).

The Transportation Research Board (TRB) is preparing a synthesis on Utility Pole Safety and Hazard Evaluation Approaches. This is being conducted for the National Cooperative Highway Research Program (NCHRP), under sponsorship of the American Association of State Highway and Transportation Officials (AASHTO), in cooperation with the Federal Highway Administration (FHWA). The objective of this synthesis is to summarize the strategies, policies, and technologies that state transportation agencies (STAs) and utility owners use to address these safety issues.

We ask that you distribute the survey to the person within your department who is most knowledgeable on the subject of utility pole safety, pole offset, and collision prevention. Please complete and submit this survey by 2 weeks from today. We estimate that it should take about 15 minutes to complete. Thank you very much for taking the time to provide this valuable input to this synthesis report. Participants will be emailed a link to the final synthesis report.

Please contact Charlie Zegeer at (zegeer@hsrc.unc.edu) if you have any questions, or call me at (919) 368-0613.Every year in the US., there are an estimated 75,000 collisions, 30,000 serious injuries and 1000 deaths involving vehicles striking utility poles (i.e., one collision every 7 minutes). Roadway departure crashes account for more than 50 percent of the total traffic-related fatalities and serious injuries in the U.S., with utility poles representing the second largest group of fixed-object fatal crashes. (Reference: P. Scott and D. Ivey, “Utility Pole Crashes”, Transportation Research Board, January, 2015).

## Survey Questions and Responses

The STA survey questions are given below, along with individual responses to each question.

**1. Please tell us who you are.**

Responses to the Utility Pole Synthesis survey were obtained from 46 state transportation agencies (STAs). Responses were provided by officials in the utility accommodation section, the crash analysis section, and/or the safety engineering section of each STA. One or more of the following methods was used to obtain this information:

a. Survey Monkey
b. Email correspondence
c. Telephone contact
d. Email and telephone.

**2. What guidance is used by your Department to determine the placement of utility poles for urban and rural roads (or provide a link to the state's utility pole placement guidelines)?**

A summary of a link to all 50 STA Utility Pole Placement Guidelines is included in this document as Appendix A.

**Do the standards for utility pole placement apply equally to new poles and existing poles? If not, what are the differences?**

A total of 18 STAs answered Yes, and 2 STAs answered No, while 26 STAs either did not know or did not answer the question directly. No STAs provided specific information on what were those differences between new and existing utility pole placement guidance. Some of that detail is provided in STA utility accommodation guidelines for a few of the states (see links in Appendix A).

**3. What circumstances might allow for a utility pole owner to be granted an exception to the normal pole-placement requirements that the State has established?**

Exceptions listed by STAs include:

- [Exceptions are granted where] protection is provided from pole collisions using guardrail or other barrier, etc.
- Design exception/design waiver process is in the Preconstruction Manual. See the link to the above manuals.
- A Design Standard Decision Document is required to deviate from the established standard. There could be various reasons, e.g., the proposed pole placement is at the right-of-way line, which is furthest from the ETW, and there is no other alternative.

- According to Section 3.3.5.3, "The Department shall review and accept utility plans…" This is where exceptions could be granted. However, exceptions are rarely made because all pole placements need to meet (AASHTO) clear zone requirements.
- The main reason is that the ROW is not wide enough to allow for poles to be placed within the ROW but out of the clear zone. Or utility placements pre-date requirement to adhere to clear zone.
- These are rarely granted. The utilities must meet our requirements.
- Several factors are considered like cost, overall impact to the project (staging, construction time, etc.), constructability, impacts to other utilities, ADA compliance, context sensitive design, and environmental impacts.
- An exception might be granted for "extenuating circumstances."
- We look at the surrounding area. If the current pole line is already inside the clear zone, and a pole replacement is being proposed, then an exception may be granted for that.
- An exception may be granted when a new pole needs to be placed in line with an existing pole, but the location of the existing pole does not comply with the standards. Exceptions are granted on a case-by-case basis.
- An exception may be granted in cases where a lack of right-of-way exists.
- ROW constructability is the main reason. Sometimes relocation costs are a factor, but ROW/constructability is the typical reason.
- Yes, exceptions are sometimes granted, but it depends. Poles are allowed within the highway ROW, but poles must be moved outside of the ROW if they are too close to the road.
- As stated previously, each project is evaluated individually with many factors considered, including input from the utility owners. If the Project Designer or Regional Permit Engineer doesn't find any reason to reject the pole-placement, then it will be allowed.
- [Exceptions can be granted] if it is a "hardship" to move the pole, such as if there is a jog in the ROW without a place to relocate the pole, etc.
- [Limited] ROW or environmental constraints might allow for an exception.
- [Exceptions can be granted] when the pole owner (utility company) has done all that can reasonably be done to comply with the terms or conditions; the proposed modification satisfies the intent of the terms or conditions to be modified; the proposed modification represents the minimum feasible deviation from the term or condition to be modified; the reason for the requested modification is the infeasibility of meeting the exact terms or conditions of the regulation rather than mere economic benefit to the applicant.
- Age of the pole is a consideration for an exception. New and relocated poles and attempted re-conductored poles generally have to meet clear zone design. Of course, there are exceptions.
- ROW constraints or other physical barriers are reasons for possible exceptions.

- Poles [could also receive an exception if] replaced in response to a highway construction or maintenance project. These poles would be placed outside of the designated clear zone as defined in the Vermont Roadside Design Manual.
- Standards only apply to new or relocated poles. Existing poles are grandfathered until having to be relocated or replaced.
- https://apps.leg.wa.gov/wac/default.aspx?cite=468-34-300.
  Variances are allowed [per] Utility Manual Sections 900.11, 900.12, and 900.13.
  http://www.wsdot.wa.gov/publications/manuals/fulltext/M22-87/Chapter9.pdf.
  (Description of Loc I, II, III poles is in Section 900.11.) Examples of conditions when compliance to WSDOT pole placement requirements are impracticable include (1) inadequate right of way to accommodate utility objects outside the control zone, (2) physical limitations due to terrain or topography, and (3) unjustifiably high costs to relocate or underground the utility facility.
- If there is nowhere else for the utility to be installed, a variance may be issued. Variances provide documentation on why the normal requirements cannot be met. Not every variance applied for is approved.
- An exception is considered when no other location is feasible or when the clear zone extends to the ROW line. Another example is when the location of an aboveground utility facility would interfere with a geodetic control monument. In these cases, WisDOT may require (1) the utility facility to be of approved yielding or breakaway construction or (2) the utility facility to be protected by WisDOT approved barrier such as beam guard, crash cushion, etc.
- An exception may be granted if no other location is available outside the clear zone or behind curb, etc. This (an exception) is seldom allowed.
- An exception may be granted in situations where the pole couldn’t be moved.
- Usually terrain features, such as hill and valley, may qualify for an exception. We try to keep poles in a straight line. We never allow a pole to go into the clear zone.
- Yes, there is an exception process based on a request to DOT. This [an approved exception] has never happened.
- Proposed exceptions are reviewed by higher-ups in the DOT Administration.
- There are sometimes utility accommodation exceptions, based on cost or other problems. New ROR is another example where an exception might be granted.
- This is handled per our policy through our district office.
- It depends. Poles are sometimes allowed in the highway ROW, but poles must be out of the ROW if they are too close to the road.
- There is an exception process in the utility accommodation manual, in cases where pole relocation is an extreme hardship.
- A permit may be approved, depending on field conditions, on a case-by-case basis, such as if utility companies can’t get a private easement.

- Exceptions may be granted if there is not an adequate right of way, if topography doesn't allow, or in the event of steep slopes.
- Waivers may be granted unless they cause "substantial detriment to the safety and operation of the highway and without deviating from the intent and purpose of this chapter" (see NJ Utility Guidelines).
- One reason for a possible exception approval is if there is a jog in the highway right of way.
- An exception may be granted if the cost for moving the pole is prohibitive.
- This is handled on a case-by-case basis. It must still meet clear zone requirements.
- Design exceptions must be justified.
- An exception will be considered if it does not interfere with a project, does not cause a safety concern, and is in the best interest of the utility and the state DOT.
- Terrain is a consideration in considering an exception to DOT guidelines.

**4. Does your Department have a separate code on your motor vehicle collision reporting form that indicates that a utility pole has been struck? (Yes or No)**

- 39 STAs answered Yes. 7 STAs answered No.

**5. How many fatal utility pole crashes occurred in your State in 2016? How many nonfatal crashes occurred in your State in 2016?**

This question was designed to gain an understanding of the frequency and prevalence of serious utility pole crashes in each state for the calendar year 2016. The year 2016 was selected with the expectation that complete data sets would be available to STAs.

Responses to this survey question were processed and grouped into 5 categories. The responses were categorized as:

- No response was given (4 STAs).
- A response of "I don't know" was given (16 STAs).
- The STA respondent provided questionable numbers to us, and the number of fatal crashes given was not in line with the FARS data (2 STAs).
- The combined number of "utility pole plus light pole" crash statistics was provided due to these being a combined checkbox on the state's crash report form (4 STAs).
- Utility pole crash numbers were provided, and they seemed reasonable (19 STAs).

Of the 23 (i.e., 4 + 19) STAs that were able to provide statistics on pole crashes, either (1) most of these STAs needed to conduct separate data analyses to obtain these numbers for the survey, or (2) the project team had to find the right person in the STA who could provide this information. In short, only a few of the STA Safety Engineers or Traffic Engineers had easy and direct access to the number of statewide utility pole crashes.

For the states that did provide the number of fatal and non-fatal utility pole crashes, it was not possible to obtain a comparable number of non-fatal utility pole crashes from every state because

(1) not all states have utility pole as a separate code on their crash report form; and/or (2) there are different criteria for reporting crashes from one state to another. Some state DOTs require reporting of full crash information only if one or more people were injured or killed (e.g., the state of Florida) while most states have various dollar criteria for reporting, ranging, for example, from approximately $200 to $1,000 per crash.

Also, very few of the 50 state officials contacted knew offhand how many utility pole crashes occurred in their state in 2016 without conducting a separate crash analysis. This is because they did not have routine crash summaries available by type of object struck, even for states that had "utility pole" as an object struck code on their crash report form.

Several states did conduct computer searches in response to our survey and provided us with the number of fatal and non-fatal utility pole crashes that occurred in the state in 2016. However, due to variations in crash reporting criteria and methods, these numbers for non-fatal crashes were considered not to be comparable between states.

In addition to responses from STAs on this question, a summary of fatal utility/light pole collisions was found from the FARS database, and it is included in Table B1. These numbers were obtained from FARS to provide a full picture of fatal crashes since most of the responding states did not provide this crash information. Note that this table only includes the number of fatal "utility-plus-light-pole-related" crashes (i.e., not just utility pole fatal crashes) by state. FARS obviously combines the number of fatal crashes involving utility poles and light (luminaire) poles since some (about 7 of the 46 STAs that responded to our survey) state that crash forms combine these crashes into a single code.

Some state DOTs have the ability to generate utility pole crash summaries when needed. One example is the North Carolina DOT, which reported the following crash information for 2016:

**UTILITY POLE CRASHES 2016**

**Crash Level Data* American Association of State Highway and Transportation Officials**

| Injury Level | No. of Crashes |
|---|---|
| **Fatal Crashes (K-Level)** | 39 |
| **Non-Fatal Injury/Possible Injury Crashes (A-, B-, C-Level)** | 2,413 |
| **Non-Injury/Unknown Injury Crashes** | 3,124 |
| **Total Crashes:** | 5,576 |

***This table represents crashes in which collision with a utility pole occurred in any event, or the most harmful event, of the crash sequence.**

**VEHICLE LEVEL DATA*, ****

| Injury Level | No. of Vehicles |
|---|---|
| Fatal Crashes (K-Level) | 31 |
| Non-Fatal Injury/Possible Injury Crashes (A-, B-, C-Level) | 2,328 |
| Non-Injury/Unknown Injury Crashes | 3,272 |
| Total Crashes: | 5,631 |

***This table represents crashes in which collision with a utility pole occurred in any event, or the most harmful event, of the crash sequence.**
****The injuries represented in this table are the highest level injury per vehicle.**

**VEHICLE LEVEL DATA*, ****

| Injury Level | No. of Vehicles |
|---|---|
| Fatal Crashes (K-Level) | 17 |
| Non-Fatal Injury/Possible Injury Crashes (A-, B-, C-Level) | 1,659 |
| Non-Injury/Unknown Injury Crashes | 2,663 |
| Total Crashes: | 4,339 |

***This table represents crashes only in which collision with a utility pole was the most harmful event.**
****The injuries represented in this table are the highest level injury per vehicle.**

**6. Are utility poles with a history of being struck tracked within your Department? If so, how is this accomplished?**

Of the STAs who answered this question, only four states indicated that they specifically track utility poles with a history of being struck on a routine basis. These states are New Jersey, New York, Pennsylvania, and Hawaii. Here are what was said by two of those state DOTs:

- "Individual utility poles are not tracked but we do track areas with frequently struck poles. All state road locations with at least 8 hit pole crashes within a 3,000 foot tolerance over the most recent 5 year time period are identified for potential safety countermeasures." (Pennsylvania DOT).

- "Yes. The annual network screening process identifies sites where the number of utility pole crashes is higher than expected." (New York DOT).

A few other states indicated that they have computer capabilities (e.g., mapping tools, computer sorting programs) that would allow for conducting searches of sites having high utility pole crash experiences. However, it was not clear from their responses whether these states (e.g., Alaska, Virginia) routinely conduct searches for sites with abnormally high numbers of utility pole crash sites. For example, the responses from the Virginia and Wisconsin DOT were as follows regarding whether sites or poles with a high number of pole crashes are tracked:

- "No, although their locations are available and can be identified quickly with the statewide crash data tool… (This tool) can be used to filter and search for crashes based on the data elements in our statewide crash report. The tool includes a mapping feature that returns the crash location information when a filter is run." (Virginia DOT)
- "The WSDOT's Transportation Data, GIS & Modeling office collects, processes, analyzes and reports on all the state routes and public roads, including the history of utility poles being struck." (Wisconsin DOT)

One state (Tennessee) reported that a utility owner with the state does indirectly identify which poles are struck, based on pole collision damage:

- "No. Utilities (utility companies) do not track pole strikes. They do track how often a pole is replaced. Taking traffic data comparing to frequency of pole replacement is how we correlated to determine pole/traffic incidents." (Tennessee DOT)

Several other STAs that answered this question indicated that they did not specifically track utility poles that have a history of being struck, but they provided an explanation as to how utility poles with a history of being struck might be identified through another process. For example, several officials stated that if a site or roadway section is identified as a "black spot" (high-crash location), the crashes within that section are reviewed in more detail. If numerous crashes within the high-crash site/section involve collisions with a utility pole, then pole-related countermeasures could be considered. Other specific responses are as follows:

- Crash types for run-off-road (ROR) crashes are reviewed.
- Yes, we would pick up on that. (No more details provided.)
- No, unless it is a focus area (noticing lots of fixed objects were being struck).
- Sites (involving collisions with utility poles) are not identified separately.
- We identify risky areas based on crash records.
- Utility pole crash locations are not tracked but may be seen in corridor analyses.
- We are notified if a pole gets hit and wires fall across the road.
- Not sure, but crash trends will show.

- Yes. NJ DOT keeps track of that; if more than 3 hits, it must be mitigated.
- Not specifically, but a crash site would be reviewed if a fixed object is struck.
- Yes, if it is a high crash location.
- We track hotspots but not utility pole crashes specifically.
- Black spots are identified.
- The Maintenance and Operations divisions in each of our 3 regions likely track this.
- Our safety office looks at crashes and fatalities along corridors and prioritizes these to improve safety.
- Pole strikes are not tracked on a pole-by-pole basis, but we examine 3-mile sections that have a high frequency of pole crashes. This is done in conjunction with the safety section within Traffic Operations.
- As far as I know, this data isn't tracked.
- No, this is not done, other than from a road safety audit (RSA).
- No, they are not tracked specifically, but during a corridor analysis, pole placement and pole crashes will normally be reviewed to determine if pole relocation or other improvements are needed.
- It is a possibility but has not been done in the past several years.
- Not specifically. Utilities are evaluated as projects are developed. However, locations with a history of fatal and severe injury crashes would be flagged and potentially investigated. These locations can then be submitted as applications (if on a state highway) through a quick-fix application to apply safety improvements.
- Poles are not formally tracked within the DOT, but maintenance crews keep an eye on any areas of concern.

**7. Is there a process in place to proactively identify (before a vehicular collision occurs) utility poles in high risk locations? Please write "Yes" next to all which may apply.**

There were 14 states that reported they have a process in place or did identify poles considered to be in an unsafe location and/or in need of treatment, based on one or more of the criteria listed in the question. These states are Alabama, Florida, New Jersey, Georgia, Washington, Tennessee, Arizona, Hawaii, Texas, Utah, Indiana, Wisconsin, Maryland, and Massachusetts. The numbers of states responding to specific features considered in the identification process include:

- Utility pole placed within the allowable clear zone too close to the road: 11 Yes, 35 No
- Utility pole placed at or near a lane drop: 6 Yes, 40 No
- Utility pole at or near an intersection: 6 Yes, 40 No
- Utility pole placed outside of a horizontal curve: 8 Yes, 34 No
- Utility pole placed too close to the road: 11 Yes, 35 No.

**8. Please indicate which of the following countermeasures are currently used by your Department to improve motorist safety, regarding utility poles within the highway right-of-way and have been determined to be unmovable. Please write "Yes" next to all which may apply.**

- Guardrail/Guiderail: 31 Yes, 15 No
- Crash Attenuation Barrels: 10 Yes, 36 No
- Shoulder Widening or Paving: 15 Yes, 31 No
- Rumble Strips: 19 Yes, 27 No
- Pole Visibility Features: 25 Yes, 21 No
- Steel-Reinforced Safety Poles: 7 Yes, 39 No
  (Note: The states that claimed to have steel-reinforced safety poles in use include Florida, Wyoming, Louisiana, Kansas, Hawaii, and Arizona while New Jersey mentioned the state's use of fiberglass poles. Three states indicated that such poles exist in their state but probably are not being installed anymore.)
- Utility Undergrounding: 23 Yes, 23 No
- Shared Utility Pole Agreements: 21 yes, 25 No.

**9. What are some of the funding options utilized by your Department to decrease the risk of vehicular collisions with utility poles? Please write "Yes" next to all which may apply, and indicate the type of funding (e.g., HSIP funds, state maintenance funds).**

- Federal funds: 32 STAs answered Yes, and 17 of those indicated HSIP Funds specifically.
- State funds: 25 STAs answered Yes, and some of these STAs also specified the following types of state funding sources: SHSP Matching funds, Maintenance Funds, State Safety Funds, Spot Funding, SPR (1 state). If required by design standards, utility pole-related improvements would be included in the cost of a project, which could be either federal or state funds, or both.
- Local funds: 9 STAs answered Yes. One STA mentioned a local match policy.
- Other: 4 STAs indicated other funding sources.
- None: 14 STAs indicated no known funding sources.

**10. Are you aware of any municipal/local agencies or utility providers who have developed their own programs for addressing utility pole safety concerns? Please name the agency or utility company.**

- None/unknown: 35 STAs.
- Local guidelines mentioned: 9 STAs noted local agencies that may have developed their own guidelines. The local agencies mentioned included those in Phoenix, AZ; Missoula, MT; Sioux Falls, SD; Dallas and Kyle, TX; and Anchorage and Fairbanks, AL. One STA response stated, "Some cities and counties have changed policies to only allow underground facilities."
- Utility owner guidelines mentioned: 6 STAs. Answers noted the Georgia Power Company; National Electric Code; PECO Pole Relocation Program; Eversource Electric; and Austin Energy. Several states also mentioned the National Electric Code as guidelines that are used by the in-state utility company.

## TABLE B1: NUMBER OF FATAL COLLISIONS INVOLVING UTILITY POLES AND LIGHT POLES FOR YEARS 2013-2017 (FROM FARS DATABASE)

| | 2017 | 2016 | 2015 | 2014 | 2013 | Total | Percentage |
|---|---|---|---|---|---|---|---|
| Alabama | 22 | 30 | 12 | 25 | 31 | 120 | 2.70% |
| Alaska | 3 | 3 | 1 | | 2 | 9 | 0.20% |
| Arizona | 6 | 10 | 13 | 10 | 21 | 60 | 1.35% |
| Arkansas | 5 | 4 | 2 | 4 | 11 | 26 | 0.59% |
| California | 57 | 70 | 66 | 81 | 69 | 343 | 7.72% |
| Colorado | 2 | 1 | 10 | 4 | 3 | 20 | 0.45% |
| Connecticut | 14 | 13 | 14 | 19 | 14 | 74 | 1.67% |
| Delaware | 4 | 7 | 4 | 7 | 3 | 25 | 0.56% |
| Florida | 84 | 86 | 69 | 71 | 53 | 363 | 8.17% |
| Georgia | 28 | 31 | 32 | 25 | 30 | 146 | 3.29% |
| Hawaii | 2 | 7 | 4 | 4 | 8 | 25 | 0.56% |
| Idaho | 2 | | 2 | 2 | 1 | 7 | 0.16% |
| Illinois | 36 | 28 | 28 | 37 | 27 | 156 | 3.51% |
| Indiana | 27 | 28 | 34 | 34 | 25 | 148 | 3.33% |
| Iowa | 9 | 4 | 8 | 5 | 4 | 30 | 0.68% |
| Kansas | 12 | 5 | 10 | 2 | 6 | 35 | 0.79% |
| Kentucky | 13 | 17 | 17 | 22 | 12 | 81 | 1.82% |
| Louisiana | 22 | 21 | 21 | 16 | 24 | 104 | 2.34% |
| Maine | 12 | 4 | 9 | 7 | 6 | 38 | 0.86% |
| Maryland | 21 | 20 | 18 | 14 | 16 | 89 | 2.00% |
| Massachusetts | 23 | 19 | 32 | 23 | 28 | 125 | 2.81% |
| Michigan | 22 | 18 | 26 | 18 | 19 | 103 | 2.32% |
| Minnesota | 3 | 3 | 5 | 4 | 5 | 20 | 0.45% |
| Mississippi | 11 | 8 | 7 | 16 | 14 | 56 | 1.26% |
| Missouri | 13 | 8 | 11 | 7 | 13 | 52 | 1.17% |
| Montana | 1 | 1 | 1 | | 1 | 4 | 0.09% |
| Nebraska | 6 | 4 | 8 | 3 | 3 | 24 | 0.54% |
| Nevada | 2 | 2 | 7 | 6 | 9 | 26 | 0.59% |
| New Hampshire | 4 | 5 | 7 | 3 | 4 | 23 | 0.52% |
| New Jersey | 21 | 33 | 34 | 24 | 24 | 136 | 3.06% |
| New Mexico | 2 | 4 | 2 | 1 | 1 | 10 | 0.23% |
| New York | 28 | 28 | 39 | 40 | 40 | 175 | 3.94% |
| North Carolina | 38 | 23 | 30 | 28 | 28 | 147 | 3.31% |
| North Dakota | 0 | 1 | | | | 1 | 0.02% |
| Ohio | 60 | 64 | 54 | 51 | 51 | 280 | 6.30% |
| Oklahoma | 6 | 11 | 13 | 8 | 8 | 46 | 1.04% |
| Oregon | 9 | 11 | 8 | 20 | 20 | 68 | 1.53% |
| Pennsylvania | 56 | 48 | 51 | 57 | 57 | 269 | 6.05% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Rhode Island** | 4 | 4 | 5 | 6 | 6 | 25 | 0.56% |
| **South Carolina** | 19 | 18 | 14 | 20 | 20 | 91 | 2.05% |
| **South Dakota** | 0 | 1 | 2 | 1 | 1 | 5 | 0.11% |
| **Tennessee** | 42 | 34 | 27 | 37 | 37 | 177 | 3.98% |
| **Texas** | 69 | 88 | 74 | 78 | 78 | 387 | 8.71% |
| **Utah** | 4 | 1 | 4 | 4 | 4 | 17 | 0.38% |
| **Vermont** | 4 | 2 | 2 | 2 | 2 | 12 | 0.27% |
| **Virginia** | 19 | 11 | 22 | 14 | 14 | 80 | 1.80% |
| **Washington** | 19 | 14 | 18 | 18 | 18 | 87 | 1.96% |
| **West Virginia** | 11 | 8 | 8 | 4 | 4 | 35 | 0.79% |
| **Wisconsin** | 10 | 11 | 11 | 16 | 16 | 64 | 1.44% |
| **Wyoming** | 0 | | | | | 0 | 0.00% |
| **Total** | 887 | 872 | 896 | 898 | 891 | 4,444 | 100% |

APPENDIX C

# Countermeasure Cost-Effectiveness Summary

After individual poles or a series of poles along a corridor are identified as high-risk (either based on utility pole crashes or based on their placement in high-risk locations), the next questions relate to what treatments may be justified. The second phase of the FHWA study by Zegeer and Parker in 1983, discussed earlier in the report, dealt with quantifying the crash effects of various treatment options. The treatments, which were also analyzed in terms of their potential economic feasibility, pertain to modifying the pole itself (e.g., pole relocation). A different set of countermeasures intended to indirectly reduce utility pole crashes by keeping the vehicle on the roadway (e.g., delineation, lighting, advance curve signing) and measures to reduce crash severity (e.g., guardrail or breakaway poles) are discussed later in more detail.

The Zegeer and Parker study developed expected crash effects and the cost-effectiveness (i.e., benefit/cost [B/C] ratio) of several utility pole treatments, including:

1. Placing utility lines underground (and removing the poles)
2. Increasing the lateral offset of the poles from the roadway
3. Reducing the number of poles (multiple pole use, increasing pole spacing, or using poles only on one side of the road)
4. Using combinations of increasing lateral pole offset and reducing pole density
5. Using breakaway poles.

The B/C ratios for each treatment option were based primarily on three factors: (1) the expected reduction in utility pole crashes (based on the crash prediction model), (2) estimates of countermeasure costs (based on cost estimates from utility companies throughout the U.S.), and (3) the roadside adjustment factor (RAF).

The RAF was needed to adjust for the fact that the effect of any utility pole treatment (e.g., pole relocation) must be adjusted based on the presence of trees, steep slopes, and other roadside conditions. For example, when utility poles are moved or removed, the out-of-control vehicle that would have hit the utility pole may instead (1) have no collision at all, (2) hit some other fixed object, or (3) roll over down the side slope. RAFs were determined based on the area type (urban or rural), distance of the poles from the roadway (between 2 feet and 30 feet from the road), and the coverage of other types of fixed objects (between 0 and 100%). A series of RAFs from 0 to 1.0 was developed to account for a wide range of roadside conditions, and RAFs were expressed based on the coverage of the roadside by other fixed objects and steep slopes (from 1 to 100% coverage of other fixed objects). See the full FHWA report for details of the B/C process (Zegeer and Parker. 1983. "Cost-Effectiveness of Countermeasures for Utility Pole Accidents." Washington, DC: FHWA, U.S. Department of Transportation, January).

A summary is given below of the results of the cost-effectiveness analysis for each type of countermeasure and the results from the study by Zegeer and Parker (1983). Note that costs and also crash-related safety benefits (i.e., both the numerator and denominator of the B/C calculation) may be considerably different in today's dollars than in 1983. Thus, the B/C ratios given below are primarily meant to illustrate the relative desirability of countermeasure options for various traffic and roadway conditions. More up-to-date calculations of the expected B/C ratio for individual countermeasures can be computed as described in the "Selection of Cost-Effective Countermeasures for Utility Pole Accidents—User's Manual" Zegeer and Cynecki, December 1986).

## PLACE UTILITY LINES UNDERGROUND AND REMOVE UTILITY POLES

Removing the utility poles altogether and placing the utility lines underground are usually a very costly and labor-intensive treatment. Costs for undergrounding were obtained from 21 different utility companies for the purpose of this study. Costs were found to vary widely, based on the type of utility poles, voltage of the lines, area type, construction methods, and other factors. The costs were summarized separately for (1) transmission lines (greater than 69 kv), (2) distribution lines less than 69 kv with conduit used, (3) distribution lines less than 69 kv with direct burial three-phase line, (4) less than 69 kv, direct burial, one-phase lines, and (5) telephone lines.

The B/C analysis found that it was generally not cost-effective to underground utility lines for transmission lines, electric lines requiring conduits, and three-phase electric lines because of the high costs related to these countermeasures. However, placing telephone lines underground (which is much less expensive than undergrounding large electric lines) was found to have B/C ratios greater than 1.0 for many situations and lines, as shown in Table C1.

## **TABLE C1:** SUMMARY OF BENEFIT/COST RATIOS FOR UNDERGROUNDING TELEPHONE LINES IN URBAN AREAS

| Pole Offset (Feet) | ADT | Clear, Level Roadside | | | < 10% Fixed Object Coverage | | | < 35% Fixed Object Coverage | | | < 60% Fixed Object Coverage | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pole Density (Poles/Mile) | | | Pole Density (Poles/Mile) | | | Pole Density (Poles/Mile) | | | Pole Density (Poles/Mile) | | |
| | | 30 | 50 | 70 | 30 | 50 | 70 | 30 | 50 | 70 | 30 | 50 | 70 |
| 2 | 1,000 | 1.05 | 1.73 | 2.41 | 0.85 | 1.40 | 1.95 | 0.76 | 1.26 | 1.73 | 0.67 | 1.11 | 1.54 |
| | 5,000 | 1.43 | 2.11 | 2.79 | 1.16 | 1.71 | 2.26 | 1.04 | 1.53 | 2.02 | 0.92 | 1.35 | 1.79 |
| | 10,000 | 1.90 | 2.58 | 3.26 | 1.54 | 2.09 | 2.64 | 1.38 | 1.87 | 2.36 | 1.22 | 1.65 | 2.09 |
| | 20,000 | 2.85 | 3.53 | 4.21 | 2.31 | 2.86 | 3.41 | 2.06 | 2.55 | 3.05 | 1.82 | 2.26 | 2.69 |
| | 40,000 | 4.73 | 5.41 | 6.09 | 3.83 | 4.38 | 4.93 | 3.43 | 3.92 | 4.41 | 3.03 | 3.46 | 3.90 |
| | 60,000 | 6.62 | 7.30 | 7.98 | 5.36 | 5.91 | 6.46 | 4.80 | 5.29 | 5.78 | 4.24 | 4.67 | 5.11 |
| 5 | 1,000 | 0.58 | 0.97 | 1.37 | 0.46 | 0.77 | 1.08 | 0.40 | 0.67 | 0.94 | 0.34 | 0.57 | 0.80 |
| | 5,000 | 0.80 | 1.19 | 1.58 | 0.63 | 0.94 | 1.25 | 0.55 | 0.82 | 1.09 | 0.47 | 0.70 | 0.92 |
| | 10,000 | 1.07 | 1.46 | 1.86 | 0.84 | 1.15 | 1.46 | 0.73 | 1.00 | 1.27 | 0.63 | 0.85 | 1.08 |
| | 20,000 | 1.62 | 2.01 | 2.40 | 1.27 | 1.58 | 1.89 | 1.11 | 1.38 | 1.65 | 0.94 | 1.17 | 1.40 |
| | 40,000 | 2.71 | 3.10 | 3.49 | 2.13 | 2.44 | 2.75 | 1.85 | 2.12 | 2.39 | 1.58 | 1.81 | 2.04 |
| | 60,000 | 3.79 | 4.19 | 4.58 | 2.99 | 3.29 | 3.60 | 2.60 | 2.87 | 3.14 | 2.21 | 2.44 | 2.67 |
| 10 | 1,000 | 0.36 | 0.62 | 0.88 | 0.27 | 0.47 | 0.66 | 0.23 | 0.40 | 0.56 | 0.19 | 0.33 | 0.47 |
| | 5,000 | 0.51 | 0.77 | 1.02 | 0.38 | 0.57 | 0.77 | 0.32 | 0.49 | 0.65 | 0.27 | 0.40 | 0.54 |
| | 10,000 | 0.69 | 0.95 | 1.20 | 0.51 | 0.71 | 0.90 | 0.44 | 0.60 | 0.77 | 0.36 | 0.50 | 0.64 |
| | 20,000 | 1.05 | 1.30 | 1.56 | 0.78 | 0.98 | 1.17 | 0.67 | 0.83 | 1.00 | 0.55 | 0.69 | 0.83 |
| | 40,000 | 1.76 | 2.02 | 2.28 | 1.32 | 1.51 | 1.71 | 1.13 | 1.29 | 1.46 | 0.93 | 1.07 | 1.21 |
| | 60,000 | 2.48 | 2.74 | 3.00 | 1.86 | 2.05 | 2.25 | 1.59 | 1.75 | 1.92 | 1.31 | 1.45 | 1.59 |
| 15 | 1,000 | 0.27 | 0.47 | 0.68 | 0.19 | 0.33 | 0.47 | 0.16 | 0.29 | 0.41 | 0.14 | 0.24 | 0.34 |
| | 5,000 | 0.38 | 0.59 | 0.79 | 0.27 | 0.41 | 0.55 | 0.23 | 0.35 | 0.47 | 0.19 | 0.30 | 0.40 |
| | 10,000 | 0.53 | 0.73 | 0.93 | 0.37 | 0.51 | 0.65 | 0.32 | 0.44 | 0.56 | 0.27 | 0.37 | 0.47 |
| | 20,000 | 0.81 | 1.01 | 1.21 | 0.56 | 0.70 | 0.84 | 0.48 | 0.61 | 0.73 | 0.41 | 0.51 | 0.61 |
| | 40,000 | 1.37 | 1.57 | 1.78 | 0.95 | 1.10 | 1.24 | 0.82 | 0.95 | 1.07 | 0.69 | 0.80 | 0.90 |
| | 60,000 | 1.93 | 2.14 | 2.34 | 1.35 | 1.49 | 1.63 | 1.16 | 1.28 | 1.41 | 0.98 | 1.08 | 1.18 |

Note: All values assume a cost of $36,000 per mile for undergrounding of telephone lines in urban areas.

1 foot = 0.3 m
1 pole/mile = 0.6 poles/km

**TABLE C2:** MINIMUM ANNUAL NUMBER OF UTILITY POLE CRASHES REQUIRED PER MILE FOR UNDERGROUNDING

| Pole Offset (Feet) | Rural Areas | | | Urban Area | | |
|---|---|---|---|---|---|---|
| | Telephone Lines | Electric Distribution Lines (<69 KV) Direct Bury | | Telephone Lines | Electric Distribution Lines (<69 KV) Direct Bury | |
| | | One Phase | Three Phase | | One Phase | Three Phase |
| 2 | 0.69 | 0.92 | 4.04 | 0.95 | 1.00 | 4.25 |
| 5 | 0.71 | 0.94 | 4.13 | 1.00 | 1.06 | 4.49 |
| 10 | 0.79 | 1.06 | 4.63 | 1.08 | 1.14 | 4.82 |
| 15 | 0.85 | 1.13 | 4.93 | 1.14 | 1.21 | 5.12 |
| 20 | 0.91 | 1.22 | 5.34 | 1.27 | 1.34 | 5.69 |
| 25 | 1.01 | 1.35 | 5.90 | | | |
| 30 | 1.19 | 1.59 | 6.94 | | | |

Note: 1 foot = 0.3 m

Assumes a 12 percent interest rate, a 20-year service life, a 35 percent coverage factor of fixed objects, curbs in urban areas, 6:1 and 4:1 sideslopes in rural areas, and average costs for undergrounding obtained from utility companies.

This is particularly true for situations where the telephone poles are currently within 5 feet of the roadway and the traffic volume exceeds 5,000 vehicles per day (vpd), with a relatively clear and level roadside. Consider undergrounding telephone lines in an urban area, for example, where the pole offset is 5 feet, with 50 poles per mile, an AADT of 20,000, and a relatively flat roadside free of other fixed objects. By going to the first column in Table C1with a pole offset of 5 feet, reading down to an ADT of 20,000, and 50 poles per mile in the “clear level roadside” column, the table shows a B/C ratio of 2.01. The minimum number of crashes required in order for undergrounding to be cost-effective is given in Table C2.

## RELOCATE UTILITY POLES FURTHER FROM THE ROADWAY

This countermeasure involves removing all poles from their current location and installing them further from the roadway. Here, 10 telephone and 31 electric companies provided costs for pole relocation. Costs were summarized in the report separately for:

- Wood power poles carrying less than 69 kv
- Non-wood (metal, concrete, or other) poles
- Steel transmission poles and towers.

In terms of the cost-effectiveness of pole relocation, the greatest B/C ratios occur in situations where the poles’ average distance from the roadway can be relocated to at least 10 feet from the road in the after condition. Also, relocating telephone poles is generally more cost-effective than relocating electric poles due to the considerably lower cost for moving telephone poles.

Table C3 provides B/C ratios for relocating telephone poles for various pole offset distances for various traffic volumes and pole densities. Note that Table C3 has assumed a 35% roadside coverage factor for all values. To illustrate the use of Table C3, assume that telephone poles are currently located an average of 2 feet from the roadway with an ADT of 10,000 and a density of 30 poles per mile on a road with 35% coverage of other roadside objects. Relocating the poles back to 20 feet (see the first row) from the road would result in an estimated B/C ratio of 3.44. Notice that the B/C ratio would be less than 3.44 for similar situations with more than 30 poles per mile. This is due to the added cost of relocating the additional poles.

**TABLE C3:** SUMMARY OF BENEFIT/COST RATIOS FOR RELOCATING TELEPHONE POLES AND LINES IN RURAL AREAS (ASSUMES A 35% ROADSIDE COVERAGE FACTOR)

| Pole Offset (Feet) | | | Pole Density (Poles Per Mile) | | |
|---|---|---|---|---|---|
| Before Improvement | After Improvement | ADT | 30 | 50 | 70 |
| 2 | 20 | 1,000 | 1.95 | 1.88 | 1.86 |
| | | 5,000 | 2.61 | 2.28 | 2.14 |
| | | 10,000 | 3.44 | 2.78 | 2.49 |
| | | 20,000 | 5.09 | 3.77 | 3.20 |
| 2 | 30 | 1,000 | 1.83 | 1.77 | 1.74 |
| | | 5,000 | 2.45 | 2.14 | 2.01 |
| | | 10,000 | 3.23 | 2.61 | 2.34 |
| | | 20,000 | 4.78 | 3.54 | 3.01 |
| 5 | 20 | 1,000 | 0.83 | 0.80 | 0.79 |
| | | 5,000 | 1.11 | 0.97 | 0.91 |
| | | 10,000 | 1.46 | 1.18 | 1.06 |
| | | 20,000 | 2.16 | 1.60 | 1.36 |
| 5 | 30 | 1,000 | 0.85 | 0.82 | 0.81 |
| | | 5,000 | 1.14 | 0.99 | 0.93 |
| | | 10,000 | 1.50 | 1.21 | 1.08 |
| | | 20,000 | 2.21 | 1.64 | 1.39 |
| 10 | 20 | 1,000 | 0.28 | 0.27 | 0.26 |
| | | 5,000 | 0.37 | 0.32 | 0.30 |
| | | 10,000 | 0.48 | 0.39 | 0.35 |
| | | 20,000 | 0.72 | 0.53 | 0.45 |
| 10 | 30 | 1,000 | 0.36 | 0.35 | 0.34 |
| | | 5,000 | 0.49 | 0.42 | 0.40 |
| | | 10,000 | 0.64 | 0.52 | 0.46 |
| | | 20,000 | 0.95 | 0.70 | 0.59 |

Note: Values assume a cost of $345 per pole.

1 foot = 0.3 m
1 pole/mile = 0.6 poles/km

## REDUCE POLE DENSITY

Reducing utility pole density can include three different types of strategies: (1) increasing the spacing between poles, (2) using a line of poles for multiple purposes (e.g., to carry electric and telephone lines together), and (3) using one line of poles instead of two lines. Increasing pole spacing may require the use of larger stronger poles to carry the heavier loads since pole spacing is computed based on structural considerations. Of course, having larger sturdier poles might result in more severe crash outcomes when struck by motor vehicles. Regarding cost-effectiveness considerations, the cost of increasing pole spacing from an existing line of poles can be comparable to the cost of pole relocation.

Multiple pole use, or doubling up the types of utility lines carried by the same poles, has been a common practice by utility companies for many years. This includes having electric, telephone, cable, television, and other communication services, in addition to supporting luminaires along highway rights-of-way, in an effort to decrease distribution costs. The costs for implementing changes in pole density depend on the configuration of the utility poles and lines and on the ease of relocating the poles.

Converting from two lines of poles to one line generally requires eliminating poles from the side of the road where poles are closest to vehicle travel. There are some situations where a double line of poles exists on the same side of the road, carrying different types of utility lines. In this situation, reducing pole density would involve removing the line of poles closest to the road and doubling utility lines on the other poles.

The utility pole crash prediction model was also used to calculate the safety benefit of having fewer poles per mile for various roadway conditions, whether it is increasing pole spacing (for poles on one side of the road) or whether the treatment is multiple pole use (where poles on one side of the road are removed and utility lines are doubled up on the other side of the road). The B/C ratios were generally found to be below 1.0 for most examples involving increasing pole spacing since this would incur the cost of basically moving every pole, which would have only a minimal safety benefit from only a small reduction in the number of poles. However, multiple pole use was found to be generally cost-effective for many situations. For example, Table C4 shows higher B/C ratios for situations with a greater number of poles per mile and lower pole offset. Consider, for example, a situation with poles on both sides of the road that average 2 feet away, with 50 poles per mile on a flat roadside clear of most other obstacles. By removing poles on one side and doubling lines on poles on the other side, the B/C ratio would be expected to be approximately 3.52, as shown in Table C4. The minimum number of crashes that is required in order for multiple pole use to be cost-effective is given in Table C5.

**TABLE C4:** SUMMARY OF BENEFIT/COST RATIOS FOR MULTIPLE POLE USE

| Pole Offsets (Feet) | Pole Density (Poles/Mile) | Rural Areas | | | | Urban Areas | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Clear, Level Roadside 0% Fixed Object Coverage | Low Fixed Object Coverage ≤10% | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside 0% Fixed Object Coverage | Low Fixed Object Coverage ≤10% | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) |
| 2 | 30 | 2.11 | 1.31 | 1.05 | 0.79 | 1.67 | 1.48 | 1.30 | 1.12 |
| | 50 | 3.52 | 2.18 | 1.75 | 1.32 | 2.78 | 2.46 | 2.17 | 1.87 |
| | 70 | 4.92 | 3.05 | 2.45 | 1.84 | 3.89 | 3.45 | 3.04 | 2.62 |
| 5 | 30 | 1.22 | 0.74 | 0.59 | 0.44 | 0.96 | 0.84 | 0.72 | 0.60 |
| | 50 | 2.03 | 1.24 | 0.99 | 0.73 | 1.60 | 1.41 | 1.20 | 1.00 |
| | 70 | 2.84 | 1.74 | 1.38 | 1.03 | 2.25 | 1.97 | 1.69 | 1.40 |
| 10 | 30 | 0.80 | 0.46 | 0.35 | 0.24 | 0.64 | 0.55 | 0.46 | 0.37 |
| | 50 | 1.34 | 0.76 | 0.58 | 0.39 | 1.06 | 0.92 | 0.77 | 0.62 |
| | 70 | 1.87 | 1.07 | 0.81 | 0.55 | 1.48 | 1.29 | 1.08 | 0.87 |
| 15 | 30 | 0.63 | 0.34 | 0.25 | 0.15 | 0.50 | 0.43 | 0.36 | 0.29 |
| | 50 | 1.05 | 0.57 | 0.41 | 0.25 | 0.83 | 0.72 | 0.60 | 0.48 |
| | 70 | 1.47 | 0.80 | 0.58 | 0.35 | 1.16 | 1.01 | 0.85 | 0.68 |

Note: 1 foot = 0.3 m
1 pole/mile = 0.6 poles/km

**TABLE C5:** SUMMARY OF THE MINIMUM NUMBER OF UTILITY POLE CRASHES TO ENSURE COST-EFFECTIVENESS OF MULTIPLE POLE USE IN URBAN AREAS

| | Clear, Level Roadside 0% Fixed Object Coverage | | | Low Fixed Object Coverage (≤10%) | | | Medium Fixed Object Coverage (≤35%) | | | High Fixed Object Coverage (≤60%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pole Density (Poles/Mile) | | | Pole Density (Poles/Mile) | | | Pole Density (Poles/Mile) | | | Pole Density (Poles/Mile) | | |
| ADT | 30 | 50 | 70 | 30 | 50 | 70 | 30 | 50 | 70 | 30 | 50 | 70 |
| 1,000 | 0.42 | 0.42 | 0.42 | 0.47 | 0.48 | 0.48 | 0.55 | 0.56 | 0.56 | 0.67 | 0.67 | 0.67 |
| 5,000 | 0.57 | 0.51 | 0.48 | 0.65 | 0.58 | 0.55 | 0.76 | 0.68 | 0.65 | 0.92 | 0.82 | 0.78 |
| 10,000 | 0.77 | 0.63 | 0.57 | 0.87 | 0.72 | 0.65 | 1.02 | 0.84 | 0.76 | 1.23 | 1.01 | 0.91 |
| 20,000 | 1.15 | 0.86 | 0.74 | 1.32 | 0.98 | 0.84 | 1.54 | 1.15 | 0.98 | 1.85 | 1.38 | 1.18 |
| 40,000 | 1.93 | 1.33 | 1.07 | 2.20 | 1.51 | 1.22 | 2.58 | 1.77 | 1.42 | 3.10 | 2.13 | 1.71 |
| 60,000 | 2.71 | 1.79 | 1.40 | 3.09 | 2.05 | 1.60 | 3.61 | 2.39 | 1.87 | 4.35 | 2.88 | 2.25 |

Note: 1 pole/mile = 0.6 poles/km

## COMBINE REDUCTION IN POLE DENSITY AND POLE RELOCATION FURTHER FROM THE ROAD

This treatment is less common since it not only requires space to move the pole further from the road but also means that the utility owner must decide to use more structurally strong poles in order to handle the added weights per pole of having increased spacing. Costs for this measure were calculated based on costs obtained from numerous utility company owners for various pole treatment situations.

## CONVERT TO STEEL-REINFORCED SAFETY (BREAKAWAY) POLES

This countermeasure involves modifying selected poles that are in high-risk locations (e.g., very close to the road on the outside of a horizontal curve) by incorporating steel hardware to the pole to allow it to break away when impacted by an errant vehicle, resulting in slower deceleration and less severe outcomes for the vehicle occupants. The use of these pole features was initiated several decades ago in four states on a trial basis but has not gained widespread acceptance yet. At the time of their introduction in the 1980s, the cost of converting to steel-reinforced features cost around $1,000 per pole, but costs are likely higher now.

The cost-effectiveness of the steel-reinforced safety pole is more difficult to determine because of limited information about the relative reduction in crash severity that would be expected due to converting selected poles from a wood base to a steel-reinforced breakaway base. For the Zegeer and Parker 1983 study for FHWA, an estimated B/C ratio was computed with two different assumptions, that this treatment would reduce the injury and fatal crashes by 30% and by 60%. Under the 30% assumption, this pole treatment was primarily cost-effective (i.e., B/C greater than 1.0) for roads with ADTs above 20,000 and with pole offsets of 2 feet and fewer than 60 poles per mile.

If this pole treatment results in a 60% reduction in injuries and fatal pole crashes, it would be cost-effective under a wide variety of roadway situations for ADTs as low as 5,000, with any pole offsets, and even for some poles that are 10 or 15 feet from the road, as shown in Table C6. Note that the pilot study of the steel-reinforced poles in four states did show that they were highly effective in producing a much less severe outcome for any strikes that did occur to poles having this safety feature.

**TABLE C6:** SUMMARY OF BENEFIT/COST RATIOS FOR BREAKAWAY POLES (ASSUMING A 30% AND 60% REDUCTION IN INJURIES AND FATAL CRASHES)

| Pole Offset (Feet) | ADT | Assuming a 30% Reduction in Injury and Fatal Accidents | | | Assuming a 60% Reduction in Injury and Fatal Accidents | | |
|---|---|---|---|---|---|---|---|
| | | Pole Density (Poles/Mile) | | | Pole Density (Poles/Mile) | | |
| | | 30 | 50 | 70 | 30 | 50 | 70 |
| 2 | 1,000 | 0.45 | 0.44 | 0.44 | 0.65 | 0.64 | 0.64 |
| | 5,000 | 0.61 | 0.54 | 0.51 | 0.88 | 0.78 | 0.74 |
| | 10,000 | 0.81 | 0.66 | 0.59 | 1.17 | 0.96 | 0.86 |
| | 20,000 | 1.21 | 0.90 | 0.76 | 1.76 | 1.30 | 1.11 |
| | 40,000 | 2.01 | 1.38 | 1.11 | 2.92 | 2.00 | 1.61 |
| | 60,000 | 2.81 | 1.86 | 1.45 | 4.08 | 2.70 | 2.11 |
| 5 | 1,000 | 0.25 | 0.25 | 0.25 | 0.36 | 0.36 | 0.36 |
| | 5,000 | 0.34 | 0.30 | 0.29 | 0.49 | 0.44 | 0.42 |
| | 10,000 | 0.45 | 0.37 | 0.34 | 0.66 | 0.54 | 0.49 |
| | 20,000 | 0.69 | 0.51 | 0.44 | 1.00 | 0.74 | 0.63 |
| | 40,000 | 1.15 | 0.79 | 0.63 | 1.67 | 1.15 | 0.92 |
| | 60,000 | 1.61 | 1.07 | 0.83 | 2.34 | 1.55 | 1.21 |
| 10 | 1,000 | 0.15 | 0.16 | 0.16 | 0.22 | 0.23 | 0.23 |
| | 5,000 | 0.21 | 0.19 | 0.19 | 0.31 | 0.28 | 0.27 |
| | 10,000 | 0.29 | 0.24 | 0.22 | 0.42 | 0.35 | 0.32 |
| | 20,000 | 0.44 | 0.33 | 0.28 | 0.64 | 0.48 | 0.41 |
| | 40,000 | 0.75 | 0.51 | 0.41 | 1.09 | 0.75 | 0.60 |
| | 60,000 | 1.05 | 0.70 | 0.55 | 1.53 | 1.01 | 0.79 |
| 15 | 1,000 | 0.12 | 0.12 | 0.12 | 0.17 | 0.18 | 0.18 |
| | 5,000 | 0.16 | 0.15 | 0.14 | 0.24 | 0.22 | 0.21 |
| | 10,000 | 0.22 | 0.19 | 0.17 | 0.32 | 0.27 | 0.25 |
| | 20,000 | 0.34 | 0.26 | 0.22 | 0.50 | 0.37 | 0.32 |
| | 40,000 | 0.58 | 0.40 | 0.32 | 0.85 | 0.58 | 0.47 |
| | 60,000 | 0.82 | 0.54 | 0.43 | 1.19 | 0.79 | 0.62 |

Note: 1 foot = 0.3 m
1 pole/mile = 0.6 poles/km

## COUNTERMEASURE COST-EFFECTIVENESS

The analysis results from the 1983 FHWA Zegeer and Parker study were compiled into a format that allows a user to quickly determine what countermeasures are generally cost-effective for a given set of site-specific conditions. Such guidelines might also be useful in selecting countermeasures that are to be more formally evaluated later. The guidelines contained in this discussion are intended for urban, suburban, and rural divided and undivided roadways. The results do not apply to freeways or other full-access controlled highways. The following guidelines are intended to help the user review a utility pole safety problem and then select the candidate countermeasures that are most likely to be cost-effective.

It should be remembered that the B/C values are based on an average set of conditions in terms of utility pole types, pole placement and density, traffic ADT, and condition of the roadside where the utility poles are located. Therefore, a more detailed site-specific analysis is recommended prior to the final selection of a countermeasure, and the Utility Pole User Guide allows for such a more refined cost-effective analysis to select the optimal solution for a given roadway and utility pole situation.

## SELECTION OF COST-EFFECTIVE COUNTERMEASURES

Based on the calculation of B/C ratios for the utility pole treatments discussed above, the Zegeer and Parker study developed a series of tables that provide an overview of which countermeasures are generally cost-effective (i.e., have a B/C cost ratio of 1.0 or above) for various combinations of traffic and roadway features. These guidelines described below are for urban, suburban, and rural roadways on divided and undivided roadways, but they do not pertain to freeways. The guidelines include roadways with vehicle ADTs between 1,000 and 60,000, pole offsets of 2 feet to 20 feet, pole densities from 0 to more than 60 poles per mile, and a variety of roadside conditions. These guidelines are intended to assist the user in identifying which countermeasure options are likely to be cost-effective.

To illustrate how these guidelines were displayed, Table C7 corresponds to cost-effective countermeasures for telephone poles that are present along urban streets. A series of matrix cells is provided that contains letters for some cells corresponding to countermeasures that are cost-effective. Cells were created consisting of various combinations of pole offset distance, pole density, ADT, and roadside coverage of other fixed objects. The letters in the matrix cells correspond to various countermeasures, such as underground lines (U), relocation of utility poles further from the road (R), multiple pole use (M), and breakaway (steel-reinforced safety poles) poles (B). A circled letter is defined as a different location distance (circled R) or an assumed reduction in severity from the installation of a breakaway device (circled B). An empty matrix cell means that none of those countermeasures is generally cost-effective for the given combination of conditions.

A quick review of Table C7 reveals that most of the matrix cells in the upper and right-hand corner of Table C7 contain several symbols. This is because poles are close to the roadway with high vehicle volumes in this part of the table, and, therefore, there is a high likelihood for numerous possible cost-effective solutions for these roadway situations. Notice that situations in the lower portion of the table typically have few or no symbols in those cells, meaning that none of the listed countermeasures is generally cost-effective since the poles are already further from the road. Also, the columns that represent flat roadsides with no other fixed objects have more cost-effective treatments (i.e., more symbols in the matrix cells), compared to similar roadways with higher coverage (up to 60%) of fixed objects. This is because the clear flat roadsides will have fewer crashes involving trees or other objects after moving or removing the poles by pole relocation or undergrounding, for example.

Consider, for example, a roadway section that has 65 poles per mile, located an average of 2 feet from the road with an ADT of 30,000 and 35% coverage of roadside obstacles. The cell corresponding to this set of conditions would have several cost-effective countermeasures, including relocation of poles to 10 feet (assuming adequate right-of-way exists and there is a circled R), breakaway poles (B), undergrounding (U), or multiple pole use (M). To determine which of these treatments is optimal for this set of conditions, a more formal analysis is needed where more specific site conditions are used. A similar roadway having the poles at an average of 20 feet from the road would have none of these countermeasures as cost-effective, i.e., there are no symbols in any of those cells in the lower part of that table.

**TABLE C7:** GUIDELINES FOR COST-EFFECTIVE COUNTERMEASURES FOR UTILITY POLE CRASHES: TELEPHONE LINES AND POLES IN URBAN AREAS

Legend

- U = Underground utility lines
- Ⓡ = Relocate utility poles to 10 feet (3 m)
- R = Relocate utility poles to 20 feet (6 m)
- B = Breakaway poles (assuming a 60 percent reduction in injury and fatal utility pole accidents)
- Ⓑ = Breakaway poles (assuming a 30 percent reduction in injury and fatal utility pole accidents will result)
- M = Multiple pole use (reduce pole density by 50 percent)

| Pole Offset (Feet) | Pole Density (Poles/Mile) | ADT = 1000-5000 Roadside Condition | | | | ADT = 5000-10,000 Roadside Condition | | | | ADT = 10,000-20,000 Roadside Condition | | | | ADT = 20,000-40,000 Roadside Condition | | | | ADT = 40,000-60,000 Roadside Condition | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) |
| 2 | <40 | U Ⓡ M | Ⓡ M | Ⓡ M | Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M |
| | 41-60 | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M |
| | >60 | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M | U Ⓑ Ⓡ M |
| 5 | <40 | R | R | | | R | R | R | | U Ⓡ | Ⓡ | R | R | U B Ⓡ | U B Ⓡ | U B Ⓡ | U B Ⓡ | U Ⓑ Ⓡ | U Ⓑ Ⓡ | U Ⓑ Ⓡ | U Ⓑ Ⓡ |
| | 41-60 | U R M | M | M | M | U R M | U R M | R M | M | U R M | U R M | U R M | R M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U R M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M |
| | >60 | U R M | U M | U M | M | U R M | U R M | U M | U M | U R M | U R M | U R M | U M | U Ⓡ M | U Ⓡ M | U R M | U R M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M |
| 10 | <40 | | | | | | | | | | | | | U R | R | | | U B R | U B R | U B R | U B R |
| | 41-60 | M | | | | M | | | | U M | | | | U M | U | | | U R M | U R | U | U |
| | >60 | M | M | M | | U M | M | M | | U M | U M | M | | U M | U M | U M | | U R M | U M | U M | U |
| 15 | <40 | | | | | | | | | | | | | | | | | U | U | | |
| | 41-60 | | | | | | | | | | | | | U | | | | U | U | U | |
| | >60 | M | M | | | M | M | | | U M | M | | | U M | M | | | U M | U M | U | U |
| 20 | <40 | | | | | | | | | | | | | | | | | U | | | |
| | 41-60 | | | | | | | | | | | | | | | | | U | | | |
| | >60 | | | | | | | | | | | | | U | | | | U | U | | |

Note: 1 foot = 0.3 m
1 pole/mile = 0.6 poles/km

Table C8 provides a similar overview of which countermeasures are cost-effective for telephone poles, except that it pertains to rural instead of urban areas. ADT categories range from 1,000 to 20,000 vehicles per day in Table C8, compared to ADT ranges of 1,000 to 60,000 in Table C7, which reflects lower vehicle volumes in rural areas. Note that Table C7 and Table C8 only involve countermeasures for telephone poles. Similar tables are given for larger poles that carry one-phase and electric distribution lines in Table C9 and Table C10 and for three-phase electric distribution lines in Table C11 and Table C12. No separate chart was provided for transmission poles/towers since none of these treatments was cost-effective due to the extremely high cost of moving these poles and/or the high cost of undergrounding the power lines.

**TABLE C8:** GUIDELINES FOR COST-EFFECTIVE COUNTERMEASURES FOR UTILITY POLE CRASHES: TELEPHONE LINES AND POLES IN RURAL AREAS

| | | ADT = 1000-5000 | | | | ADT = 5000-10,000 | | | | ADT = 10,000-20,000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Roadside Condition | | | | Roadside Condition | | | | Roadside Condition | | | |
| Pole Offset (Feet) | Pole Density (Poles/Mile) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (<10%) | Medium Fixed Object Coverage (<35%) | High Fixed Object Coverage (<60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (<10%) | Medium Fixed Object Coverage (<35%) | High Fixed Object Coverage (<60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (<10%) | Medium Fixed Object Coverage (<35%) | High Fixed Object Coverage (<60%) |
| 2 | <40 | U Ⓡ M | U Ⓡ M | U Ⓡ M | Ⓡ | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ |
| | 41-60 | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M | U B Ⓡ M |
| | >60 | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ M |
| 5 | <40 | U Ⓡ M | R | | | U Ⓡ M | U Ⓡ | Ⓡ | Ⓡ | U Ⓡ M | U Ⓡ | U Ⓡ | Ⓡ |
| | 41-60 | U Ⓡ M | U R M | U | | U Ⓡ M | U Ⓡ M | U Ⓡ | | U Ⓡ M | U Ⓡ M | U Ⓡ | U Ⓡ |
| | >60 | U Ⓡ M | U R M | U M | U | U Ⓡ M | U Ⓡ M | U Ⓡ M | U | U Ⓡ M | U Ⓡ M | U Ⓡ M | U Ⓡ |
| 10 | <40 | | | | | U R | | | | U R | | | |
| | 41-60 | U M | | | | U M | | | | U R M | U | | |
| | >60 | U M | U M | | | U M | U M | | | U R M | U M | U | |
| 15 | <40 | | | | | | | | | U | | | |
| | 41-60 | U M | | | | U M | | | | U M | | | |
| | >60 | U M | | | | U M | | | | U M | U | | |
| 20 | <40 | | | | | | | | | | | | |
| | 41-60 | | | | | U | | | | U | | | |
| | >60 | U M | | | | U M | | | | U M | | | |

Note: 1 foot = 0.3 m
1 pole/mile = 0.6 poles/km

It should be noted that the information in Tables C9 through Table C12 provides general guidelines on which of the countermeasures are cost-effective for a given combination of site conditions, using average countermeasure costs obtained from dozens of utility companies across the nation. Also, the average or expected utility pole crash experience was used, as determined in the crash modeling analysis from the four states. To obtain a more precise assessment of the B/C ratios of countermeasures being considered for a given roadway situation, it is important to use the latest costs for motor vehicle crashes as well as the crash effects discussed earlier.

Note that these tables do not include countermeasures such as installing guardrails or crash cushions. Such barriers and other devices may be the preferred solution for numerous roadway and utility pole situations, particularly where the poles are in high-risk locations but cannot be moved for whatever reason.

**TABLE C9:** GUIDELINES FOR COST-EFFECTIVE COUNTERMEASURES FOR UTILITY POLE CRASHES: ONE-PHASE ELECTRIC DISTRIBUTION LINES (< 69 kV) IN URBAN AREAS

Legend

U = Underground utility lines

Ⓡ = Relocate utility poles to 10 feet (3 m)

R = Relocate utility poles to 20 feet (6 m)

B = Breakaway poles (assuming a 60 percent reduction in injury and fatal utility pole accidents)

Ⓑ = Breakaway poles (assuming a 30 percent reduction in injury and fatal utility pole accidents will result)

M = Multiple pole use (reduce pole density by 50 percent)

| | | ADT = 1000-5000 | | | | ADT = 5000-10,000 | | | | ADT = 10,000-20,000 | | | | ADT = 20,000-40,000 | | | | ADT = 40,000-60,000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Roadside Condition | | | | Roadside Condition | | | | Roadside Condition | | | | Roadside Condition | | | | Roadside Condition | | | |
| Pole Offset (Feet) | Pole Density (Poles/Mile) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) |
| 2 | <40 | U | | | | U R B | U B | U B | B | U Ⓡ B | U Ⓡ B | U R B | U B | U Ⓡ Ⓑ | U Ⓡ Ⓑ | U Ⓡ Ⓑ | U Ⓡ Ⓑ | U Ⓡ Ⓑ | U Ⓡ Ⓑ | U Ⓡ Ⓑ | U Ⓡ Ⓑ |
| | 41-60 | U | U | U | U | U | U | U | U | U R B | U R B | U B | U B | U Ⓡ Ⓑ | U Ⓡ Ⓑ | U Ⓡ Ⓑ | U Ⓡ Ⓑ | U Ⓡ Ⓑ | U Ⓡ Ⓑ | U Ⓡ Ⓑ | U Ⓡ Ⓑ |
| | >60 | U | U | U | U | U | U | U | U | U | U | U | U | U Ⓡ B | U R B | U R B | U B | U Ⓡ Ⓑ | U Ⓡ Ⓑ | U Ⓡ Ⓑ | U Ⓡ Ⓑ |
| 5 | <40 | | | | | | | | | U | | | | U B | U B | U B | B | U R Ⓑ | U R Ⓑ | U R Ⓑ | U Ⓑ |
| | 41-60 | U | | | | U | | | | U | U | U | | U | U | U | U | U B | U B | U B | U B |
| | >60 | U | U | | | U | U | U | | U | U | U | U | U | U | U | U | U B | U B | U B | U B |
| 10 | <40 | | | | | | | | | | | | | U | | | | U B | U B | U B | B |
| | 41-60 | | | | | | | | | U | | | | U | U | | | U | U | U | |
| | >60 | | | | | U | | | | U | | | | U | U | U | | U | U | U | |
| 15 | <40 | | | | | | | | | | | | | | | | | U | U | U | |
| | 41-60 | | | | | | | | | | | | | U | | | | U | U | U | |
| | >60 | | | | | | | | | | | | | U | | | | U | U | U | |
| 20 | <40 | | | | | | | | | | | | | | | | | U | | | |
| | 41-60 | | | | | | | | | | | | | | | | | U | | | |
| | >60 | | | | | | | | | | | | | U | | | | U | | | |

Note: 1 foot = 0.3 m
1 pole/mile = 0.6 poles/km

**TABLE C10:** GUIDELINES FOR COST-EFFECTIVE COUNTERMEASURES FOR UTILITY POLE CRASHES: ONE-PHASE ELECTRIC DISTRIBUTION LINES (< 69 kV) IN RURAL AREAS

**Legend**

- **U** = Underground utility lines
- **(R)** = Relocate utility poles to 20 feet (6 m)
- **R** = Relocate utility poles to 30 feet (9 m)
- **B** = Breakaway poles (assuming a 60 percent reduction in injury and fatal utility pole accidents)
- **(B)** = Breakaway poles (assuming a 30 percent reduction in injury and fatal utility pole accidents will result)
- **M** = Multiple pole use (reduce pole density by 50 percent)

| | | ADT = 1000-5000 | | | | ADT = 5000-10,000 | | | | ADT = 10,000-20,000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Roadside Condition | | | | Roadside Condition | | | | Roadside Condition | | | |
| Pole Offset (Feet) | Pole Density (Poles/Mile) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) |
| 2 | <40 | U | U | | | U B (R) | U B | U B | B | U B (R) | U B (R) | U B (R) | U B |
| | 41-60 | U | U | U | U | U (R) | U | U | U | U B (R) | U B R | U B | U B |
| | >60 | U | U | U | U | U (R) | U | U | U | U (R) | U | U | U |
| 5 | <40 | | | | | U | | | | U | U | | |
| | 41-60 | U | | | | U | U | | | U | U | U | |
| | >60 | U | U | U | | U | U | U | | U | U | U | U |
| 10 | <40 | | | | | | | | | U | | | |
| | 41-60 | U | | | | U | | | | U | | | |
| | >60 | U | | | | U | | | | U | U | | |
| 15 | <40 | | | | | | | | | | | | |
| | 41-60 | | | | | | | | | U | | | |
| | >60 | U | | | | U | | | | U | | | |
| 20 | <40 | | | | | | | | | | | | |
| | 41-60 | | | | | | | | | U | | | |
| | >60 | | | | | U | | | | U | | | |

Note: 1 foot = 0.3 m
1 pole/mile = 0.6 poles/km

C-16 Utility Pole Safety and Hazard Evaluation Approaches

**TABLE C11:** GUIDELINES FOR COST-EFFECTIVE COUNTERMEASURES FOR UTILITY POLE CRASHES: THREE-PHASE ELECTRIC DISTRIBUTION LINES (<69 kV) IN URBAN AREAS

Legend

- U = Underground utility lines
- (R) = Relocate utility poles to 10 feet (3 m)
- R = Relocate utility poles to 20 feet (6 m)
- (r) = Relocate non-wood utility poles to 10 feet (3 m)
- r = Relocate non-wood utility poles to 20 feet (6 m)
- B = Breakaway poles (assuming a 60 percent reduction in injury and fatal utility pole accidents)
- (B) = Breakaway poles (assuming a 30 percent reduction in injury and fatal utility pole accidents will result)
- M = Multiple pole use (reduce pole density by 50 percent)

| Pole Offset (Feet) | Pole Density (Poles/Mile) | ADT = 1000-5000 | | | | ADT = 5000-10,000 | | | | ADT = 10,000-20,000 | | | | ADT = 20,000-40,000 | | | | ADT = 40,000-60,000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Roadside Condition | | | | Roadside Condition | | | | Roadside Condition | | | | Roadside Condition | | | | Roadside Condition | | | |
| | | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) |
| 2 | <40 | | | | | B | B | B | B | B r | B | B | B | (B) (r) | (B) (r) | (B) (r) | (B) (r) | U (B) (r) (R) | (B) (r) (R) | (B) (r) (R) | (B) (r) (R) |
| | 41-60 | | | | | | | | | B | B | B | B | (B) r | (B) r | (B) | (B) | U (B) (r) R | U (B) (r) R | (B) (r) | (B) (r) |
| | >60 | | | | | | | | | | | | | U B r | B | B | B | U (B) (r) | U (B) (r) R | U (B) (r) | (B) r |
| 5 | <40 | | | | | | | | | | | | | B | B | B | B | (B) r | (B) r | (B) | (B) |
| | 41-60 | | | | | | | | | | | | | | | | | B | B | B | B |
| | >60 | | | | | | | | | | | | | | | | | B | B | B | B |
| 10 | <40 | | | | | | | | | | | | | | | | | B | B | B | B |
| | 41-60 | | | | | | | | | | | | | | | | | | | | |
| | >60 | | | | | | | | | | | | | | | | | | | | |
| 15 | <40 | | | | | | | | | | | | | | | | | | | | |
| | 41-60 | | | | | | | | | | | | | | | | | | | | |
| | >60 | | | | | | | | | | | | | | | | | | | | |
| 20 | <40 | | | | | | | | | | | | | | | | | | | | |
| | 41-60 | | | | | | | | | | | | | | | | | | | | |
| | >60 | | | | | | | | | | | | | | | | | | | | |

Note: 1 foot = 0.3 m
1 pole/mile = 0.6 poles/km

## **TABLE C12:** GUIDELINES FOR COST-EFFECTIVE COUNTERMEASURES FOR UTILITY POLE CRASHES: THREE-PHASE ELECTRIC DISTRIBUTION LINES (< 69 kV) IN RURAL AREAS

Legend

**U** = Underground utility lines

Ⓡ = Relocate utility poles to 20 feet (6 m)

**R** = Relocate utility poles to 30 feet (9 m)

ⓡ = Relocate non-wood utility poles to 20 feet (6 m)

**r** = Relocate non-wood utility poles to 30 feet (9 m)

**B** = Breakaway poles (assuming a 60 percent reduction in injury and fatal utility pole accidents)

Ⓑ = Breakaway poles (assuming a 30 percent reduction in injury and fatal utility pole accidents will result)

**M** = Multiple pole use (reduce pole density by 50 percent)

| | | ADT = 1000-5000 | | | | ADT = 5000-10,000 | | | | ADT = 10,000-20,000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Roadside Condition | | | | Roadside Condition | | | | Roadside Condition | | | |
| Pole Offset (Feet) | Pole Density (Poles/Mile) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) | Clear, Level Roadside (0% Fixed Object Coverage) | Low Fixed Object Coverage (≤10%) | Medium Fixed Object Coverage (≤35%) | High Fixed Object Coverage (≤60%) |
| 2 | <40 | | | | | B | B | B | B | ⓡ B | B | B | B |
| | 41-60 | | | | | | | | | U B | B | B | B |
| | >60 | | | | | U | | | | U | | | |
| 5 | <40 | | | | | | | | | | | | |
| | 41-60 | | | | | | | | | | | | |
| | >60 | | | | | | | | | | | | |
| 10 | <40 | | | | | | | | | | | | |
| | 41-60 | | | | | | | | | | | | |
| | >60 | | | | | | | | | | | | |
| 15 | <40 | | | | | | | | | | | | |
| | 41-60 | | | | | | | | | | | | |
| | >60 | | | | | | | | | | | | |
| 20 | <40 | | | | | | | | | | | | |
| | 41-60 | | | | | | | | | | | | |
| | >60 | | | | | | | | | | | | |

Note: 1 foot = 0.3 m
1 pole/mile = 0.6 poles/km

APPENDIX D

# FHWA Program Guide: Utility Relocation and Accommodation on Federal-Aid Highway Projects

**CORRECTIVE MEASURES/UTILITY POLE SAFETY PROGRAMS:**

Section 645.209(k), reads as follows:

> *When the transportation department determines that existing utility facilities are likely to be associated with injury or accident to the highway user ... the highway agency shall initiate ... in consultation with the affected utilities, corrective measures ...*

*The intent of this regulation is for each State to work with pole owners to develop and implement programs to systematically remove, relocate, or mitigate hazardously-located utility poles in a reasonable, cost-effective manner.*

*A utility pole crash reduction program as envisioned in the Federal regulations should contain the following essential elements:*

- *Identification of hazardously-located utility poles.*
- *Analysis of hazardously-located poles and development of countermeasures.*
- *Establishment of a goal for removing, relocating, or mitigating hazardously-located utility poles.*
- *Actual removal, relocation, or mitigation of hazardously-located utility poles.*

*Ideally, the clear zone should be free of utility poles. Where poles exist in the clear zone, or where an analysis has shown that an existing pole located outside the clear zone may need treatment, many options are available. The following list has generally been considered as the desirable order of treatment:*

- *Remove the pole and underground the utility lines;*
- *Relocate the pole to a location where it is less likely to be struck;*
- *Reduce the number of poles by joint use, placing poles on only one side of the street, or increasing pole spacing by using bigger, taller poles;*

- *Reduce impact severity by using breakaway utility poles;*
- *Redirect a vehicle by shielding the pole with a longitudinal traffic barrier or crash cushion; and*
- *Warn of the presence of the pole if the alternatives above are not appropriate using warning signs, reflective paint, sheeting, or object markers placed on the poles.*

*There is also the possibility that keeping the driver on the road is the best solution to a crash problem. This may be done by positive guidance. For example, using pavement markings, delineators, advance warning signs, and other visual cues to tell the driver what to expect and to provide a visual path through a site.*

*Physical enhancements such as improving the skid resistance of the pavement, widening the pavement travel lanes, widening or paving shoulders, placing rumble strips on the shoulders, improving the superelevation, straightening sharp curves, decreasing the speed of vehicles, or adding lighting in areas where crashes frequently occur at night, may also diminish crash potential by decreasing the number of vehicles that for whatever reason leave the travel-way.*

*Once specific corrective actions have been determined, it is expected implementation will be pursued through a prioritization process which takes into account resources available, replacement and upgrading planned both for the utility and highway physical plants, and overall accident potential.*

*To be effective this corrective program must be a joint effort between highway authorities and the affected utilities. It is strongly encouraged that the utility companies work closely with the transportation departments in identifying problem areas and establishing schedules for corrective actions. Such schedules should take into consideration, wherever possible, a utility's planned activities on line up-gradings, replacements, and the like.*

*An orderly, planned, effective process of safety improvements over time that would take into consideration the costs to both the highway user and utility consumer is preferred.*

*The Washington State Department of Transportation (WSDOT) has a model utility pole safety program. It was developed and implemented in coordination with the affected utility pole owners. The Division Office provided invaluable encouragement and assistance. WSDOT considers the most hazardously-located utility poles to be those that are: (a) outside of horizontal curves where advisory signed speeds for the curve are 15 mph or more below the posted speed limit of that section of highway; (b) within the turn radius of public at-grade intersections; (c) where a barrier, embankment, rock outcropping, ditch, or other roadside feature is likely to direct a vehicle into a utility object; or (d) closer than 5-feet horizontal beyond the edge of the usable shoulder. A goal has been established for removing, relocating, or mitigating a certain number of hazardously-located utility poles each year. This goal applies to each company owning utility poles and takes into account the size of the utility company, the number of poles in need of attention, available funding, and other factors. Hazardously-located utility poles may be removed, relocated, or mitigated in conjunction with planned highway or utility projects or individually. All utility poles removed, relocated, or mitigated, for whatever reason, count toward the utility company's goal. Efforts are made to systematically address the worst poles first.*

*Since most hazardously-located utility poles are on highway right-of-way, State law in most States requires the owner of the poles to pay for removal, relocation, or mitigation. If, however, the State can pay and does pay, Federal funds can participate in the cost, even up to 100 percent in some cases.*

*A strong case can be made for moving utility poles if they are located so as to present a significantly greater threat to motorists than anything else along the road. But, if they are not, States should not ask the utility pole owners to do any more to improve roadside safety than they plan to do themselves.*

*Questions can arise as to the amount of corrective actions regarding utility facilities that should be undertaken as part of 3R (resurfacing, restoration, rehabilitation) projects. Overall, the FHWA has encouraged and supported efforts by each State to develop and implement reasonable and effective clear zone policies consistent with the principles set forth in the AASHTO Green Book (see above discussion of "New Above Ground Installations/ Clear Zone Policies").*

*In this respect a number of States have adopted individual 3R project design criteria that specifically addresses the clear zone issue. Considerable judgment must be exercised in actually establishing clear roadside areas on individual 3R projects to ensure that the safety benefits are reasonably commensurate with costs. Consideration should be given to this matter regardless of who pays for the utility work.*

*As clarified by FHWA's July 1988 final rule, which modified 23 CFR 645.107, costs incurred by transportation departments in implementing projects for safety corrective measures to reduce the hazards of utilities to highway users are eligible for Federal-aid participation.*

APPENDIX E

# Utility Pole and Tree Safety Case Studies

Taken Directly from:

Noteworthy Practices: Roadside Tree and Utility Pole Management, Federal Highway Administration, by Joseph Jones, Leidos, September 2016.

A 2016 report by Joseph Jones for FHWA entitled Noteworthy Practices: Roadside Tree and Utility Pole Management" provided some case studies of what some state DOT's have been doing to address roadside safety problems in recent years. The report first discusses that roadway departures accounts for a majority (56%) of fatal crashes in the U.S., and of those crashes, 40% involve striking a fixed object. Vehicles which strike trees or utility poles are said to represent 14% of all fatal crashes. The study suggests that…"*managing roadside trees and utility poles would be common strategies to reduce fatal crashes; however, most transportation agencies have indicated that they find it challenging to mitigate these obstacles. A few state departments of transportation (DOT) apply some level of roadside management in the area and their practices are examined here in greater detail.*"

The study states that mitigating crashes involving these two types of roadside objects:

> "*are arguably the most elusive of all fixed objects to control for the following reasons:*
>
> - *Trees contribute to roadside aesthetics and their removal sometimes invokes deep sentimental and environmental concerns among agencies and stakeholders (NCHRP 500, Volume 3 on Trees)*
> - *Utilities are usually privately held business enterprises that are not bound by State DOT policies. If they have rights regarding poles in public rights-of-way, they are allowed to ignore or reject requests for removal.*"

Reduced budgets for maintenance and operations are mentioned in the report, and reduced personnel are given as further reasons why more is not being done by state DOTs to address these problems. Also, the authors state that there is lower priority assigned to dealing with these safety issues. The study mentions that it attempts to present a… "snapshot of multiple methods gleaned from a cross-section of industry."

The study cites the hierarchy given in the AASHTO Roadside Design Guide for addressing hazards within the highway right-of-way:

1. Remove the obstacle (if possible).
2. Redesign the obstacle (so it can be traversed by the errant vehicle).
3. Relocate the obstacle so a collision is less likely.
4. Reduce crash severity, such as by using a breakaway feature.
5. Shield the obstacle using a longitudinal barrier or crash cushion.
6. Delineate the obstacle if the measures above are not feasible.

Since trees and utility poles are not traversable (see objective 2), the study focus is on measures that address the objectives of keeping the vehicle on the road, allowing the errant vehicle to recover after leaving the travel lane, and reducing the crash severity. Some of the specific “case studies” described from selected states are given below. The case studies taken from that report involve programs that deal with utility pole crash countermeasures, but some involve broader roadside safety approaches of efforts to reduce roadside crashes in general:

## KEEP THE VEHICLE ON THE ROADWAY

### ALABAMA DOT:

*Alabama: Applying Specific Countermeasures Corresponding to Individual Crash Types (1). Alabama’s roadside tree and utility pole management program is a direct product of FHWA’s Roadway Departure Focus States Initiative. This program identifies a State’s most critical crash types and identifies countermeasures that can be deployed to decrease fatalities and serious injuries. In response to FHWA’s analysis, the Alabama Department of Transportation (ALDOT) developed a program and funding stream to address over 400 areas in which roadside fixed object crashes were overrepresented. ALDOT established an open-ended program to focus on both curve and tree/pole problem areas. They retained two design consultants to more closely analyze each problem area and tailor a specific solution to alleviate the concern. This practical approach uses the data and context for each particular area to devise a solution rather than deploying a single treatment (e.g., clearing) statewide. While removal of trees is not ruled out—particularly those very close to the traveled way—the solutions are expected to focus on keeping drivers on the roadway, effectively preventing the trees and utility poles from being reached. This could be accomplished by installing HFST, enhanced signing or edge line rumble strips. Widening and/or paving shoulders may also be considered.*

*The ALDOT program has the potential to realize all the benefits of a narrowly focused safety solution while still achieving the widespread advantage of a systemic deployment. Since tree removal is not expected to be the primary solution identified, ALDOT anticipates very little public opposition. If any promotional marketing does need to take place, however, the DOT* *plans to highlight the expected annual reduction of 40-50 fatal crashes. While the activity described above is ongoing, ALDOT intends to accomplish most of its efforts within 5 years, as funding allows.*

*(1 Telephone Interview conducted with T. Barnett of the Alabama Department of Transportation, Office of Safety Operations, September 25, 2015).*

***WASHINGTON STATE DOT:***

*Washington: Targeting Locations through Network Analysis (2) Over half of the total land area of Washington State is forested. This vast natural resource has allowed the State to become the Nation's second largest timber producer, supporting over 100,000 jobs in that industry (3). It also means that the Washington State Department of Transportation (WSDOT) owns hundreds of miles of tree-lined roads. For that reason, the DOT has had an active policy of careful roadside tree management for decades. Currently, a sophisticated strategy is in place as part of the State's Strategic Highway Safety Plan (SHSP), but long before that, trees were dealt with as actual crashes revealed the need. Eventually, the State's paving program began to drive tree management efforts; roadside trees were considered for removal when they fell within the limits of a programmed resurfacing, restoration, and rehabilitation (3R) project. Though this was a step in the right direction, by the early 1990s the State realized an additional opportunity to manage hazards more efficiently and moved toward the program that is in place today. WSDOT conducts a biannual comprehensive network analysis that identifies broader areas of potential safety enhancements, not only tree and utility pole issues. The current plan employs a systemic-targeted approach in which countermeasures are coupled with specific crash types, and deployed globally as needed. Since this approach focuses on system performance, crash types, and contributing factors, WSDOT is able to tailor appropriate solutions to individual locations. In the case of trees and utility poles, the countermeasures deployed are generally designed to keep vehicles on the roadway: rumble strips, enhanced pavement marking, edge delineation, and HFST. As such, trees are seldom removed, and although WSDOT has a contract mechanism by which timber can be harvested on right-of-way, it is rarely used. Occasionally, the agency shields the obstacles. When shielding is needed, the State takes a two-pronged approach:*

- *Older installations (50s, 60s and 70s) that may already be shielding obstacles are inspected to verify their performance. The agency upgrades these installations as necessary.*

- *Shielding is installed—as warranted—if none is currently in place. In some locations, the only significant work in recent history may have been 3R, the scope of which generally excludes additional guardrail.*

*(2 Telephone Interview conducted with J. Ring, A. Nizam, and J. Milton of the Washington State Department of Transportation, September 23, 2015.)*

*(3 Washington Forest Protection Association, "Sustainable Forestry." Available at: http://www.wfpa.org/sustainable-forestry/)*

*WSDOT has experienced surprisingly little public opposition to their roadside tree and utility pole management strategy. This may be due to their performance-focused approach: working together with the public to achieve solutions instead of simply informing them of the plan. While satisfying the concerns of all transportation stakeholders rarely occurs, the agency has had success with achieving public consent with their analytical, data-driven approach.*

***PENNSYLVANIA: INCREASING SAFETY IN CULTURALLY SENSITIVE AREAS***

*The legislature in the State of Pennsylvania has, for over a decade, appropriated $10 million annually to fund the transportation-related "Low-Cost Safety Improvement Program." The program's funding is distributed among the Pennsylvania Department of Transportation's (PennDOT) 11 districts. Each district further allocates the money to State routes within their portion of Pennsylvania's 67 counties, which allows funding to be closely tied to the individual needs of each county in the State (4).*

*The scopes of projects within these counties vary greatly. Low-cost, systemic type projects such as HFST and rumble strip installations are most frequently undertaken, but more complex projects such as road widening or limited new construction are occasionally built. While this program is not limited to tree and pole mitigation efforts, that work is often accomplished as well.*

*While roadside tree removals are often part of the State's efforts, one notable case caused officials to consider other countermeasures. Pennsylvania Route 147 in Dauphin County is nicknamed "Sycamore Allée," for the nearly century-old mature sycamores that line its sides. Listed on the National Register of Historic Places, the tree plantings along this roadway segment north and south of Halifax have uncertain origins, though they are largely believed to have been a memorial to World War I soldiers from the county who were killed in action (5).*

*When the mature trees along Route 147 were identified as an opportunity for safety improvement, PennDOT officials immediately knew that tree removal was not an option. Instead of introducing the increased crashes inherent in excessive shielding, the DOT decided to focus on keeping vehicles on the roadway. The Department accomplished this by designing HFSTs and superelevation corrections. The initial projects containing these countermeasures are presently under construction, so no performance data is available. Like many other transportation agencies, however, PennDOT has realized a pronounced decrease in roadway departure crashes—at other locations—resulting from HFST.*

*4 Telephone Interview conducted with J. Herschock of the Pennsylvania Department of Transportation Office of Safety Engineering and Risk Management, September 23, 2015.*

*5 Pennsylvania Historic Preservation Office, "National Transportation Week: A Road to the Past," last modified: May 15, 2013. Available at: http://pahistoricpreservation.com/a-road-to-the-past/.*

### *TENNESSEE: MANAGING ROADSIDES WITH ENVIRONMENTAL CONSTRAINTS*

*The Tennessee Department of Transportation (TDOT) generally avoids removing either trees or utility poles from their rights-of-way or from adjoining properties primarily due to two factors: environmental concerns or public resistance. In Tennessee, removing trees or shrubs larger than 6 inches in diameter triggers additional environmental studies and impact statements. This is complicated by the state's being home to at least three species of endangered bats and having an environmental requirement that root wads of cut trees be left in the ground for soil stabilization. In many cases, a new tree can re-grow from the root stock. Additionally, landowners in the state are very resistant to having trees on or along their property removed, regardless of risk to motorists.*

*Being cognizant of the risks that roadside trees and utility poles present, TDOT searched for a solution that could be deployed quickly and without generating undue environmental or public relations concerns. The answer was tree and pole delineation.*

*The delineation consists of either a curved retro-reflectorized plate affixed to the tree or pole, or a standard ground-mounted flexible delineator installed near the obstacle. TNDOT began using this countermeasure with regularity in 2012. Given the low level of complication and intrusion associated with this product, the agency has not encountered any opposition on the part of transportation stakeholders or utility companies. TNDOT will only delineate utility poles that are within the clear zone, and furthermore, only those on the foreslope. This is specifically done to avoid drivers mistaking the delineation for channelization. Even with this policy in place, they field check each potential application site (in person) to determine the possibility of drivers being drawn off the road. If the team believes that possibility exists, the treatment is not used.*

*A few agencies nationwide have used this countermeasure but no research at this time provides definitive results. As such, no rating is included in the CMF Clearinghouse.*

### *ALLOWING THE VEHICLE TO REGAIN THE ROADWAY*

### *NEBRASKA: RE-ESTABLISHING CLEAR ZONES DURING RESURFACING, RESTORATION, AND REHABILITATION (3R) AS WELL AS RESURFACING, RESTORATION, REHABILITATION AND RECONSTRUCTION (4R)*

*Nebraska Department of Roads (NDOR) policy stipulates that fixed objects within the right-of-way are to be removed for any project classified as 3R and higher using the minimum clearance widths shown below. The distance cleared is variable based upon roadway functional classification and average daily traffic (ADT).*

***TABLE E1:*** *NDOR FIXED OBJECT CLEARANCE WIDTHS*

| *Functional Classification* | *Average Daily Traffic* | *Lateral Obstacle Clearance (ft)* |
|---|---|---|
| *Interstate* | *All* | *35* |
| *Expressway* | *All* | *30* |
| *Major Arterial* | *≥ 4,000* | *30* |
| *Minor Arterial* | *2,000 - 3,999* | *30* |
| *Major Arterial* | *400 - 1,999* | *23* |
| *Minor Arterial* | *< 400* | *16* |

*This practice has been in place since the 1980s, but has become especially important in recent years when Nebraska, like so many other States, changed its mowing policy. The department used to mow the entire right-of-way—from fence line to fence line—but now only mows a single pass adjacent to the roadway. This allows more substantial vegetation like trees and shrubs to take root and flourish. When adhering to NDOR's policy, obstacles of this nature are removed or otherwise controlled on the normal paving schedule: about every 10 years.*

*Since this policy is codified into State law, it is able to transcend any public opposition that may arise and, to date, the public has not voiced any opposition to NDOR concerning this practice.*

*It is important to remember that NDOR's policy goes beyond trees alone and applies to all fixed objects. Utility pole concerns within the above-specified clear recovery areas are handled on a case-by-case basis. A Roadside Safety Analysis Program assessment is usually completed and if a concern is detected, the department works with the utility company for relocation, or shields the pole.*

## ***REDUCE THE SEVERITY OF CRASHES***

### ***NEW JERSEY: USING POLES THAT ABSORB CRASH ENERGY***

*Utility pole crash fatalities are disproportionate in New Jersey, a State that ranks 22nd in all traffic fatalities, but 8th in those involving utility poles (6). Approximately 260 sites have been identified statewide as having multiple utility pole crashes over a 3-year period.*

*With this in mind, New Jersey Department of Transportation (NJDOT), in conjunction with researchers at Rowan University, developed the Pole Mitigation Program to identify and improve highest-risk utility pole crash locations. Twenty sites that are not part of any active design or construction effort have been selected for mitigation (7).*

*Within the PMP there is an effort to pilot the use of energy-absorbing poles at some locations. These poles differ in many ways from their wood and steel breakaway counterparts. The hollow poles feature composite construction consisting of filament-wound fiberglass-reinforced polyester. They are 45 feet long with a wide octagonal cross-section on the lower portion that transitions to a narrow circular cross-section near the top (8). The poles are designed to collapse upon impact as opposed to breaking away and potentially falling into traffic. Analysts observed no excessive occupant risks factors in either of two separate crash tests (9).*

*6 H. C. Gabler, D. Gabauer, and W. Riddell, Breakaway Utility Poles: Feasibility of Energy Absorbing Pole Installations in New Jersey, (Trenton, NJ: New Jersey Department of Transportation, 2007), p.8.*

*7 Foedinger, R., et al, "Development of an Energy Absorbing Pole," (paper presented at the 82nd Annual TRB Meeting, Washington DC, January 2003).*

*8 Ibid., p. 28.*

*9 Ibid., p. 29.*

*As shown below, these poles offer several advantages over traditional wooden poles.*

***TABLE E2:*** *COMPARISON OF COMPOSITE POLE TO WOODEN POLE.*

| *Characteristic* | *Composite Pole* | *Wooden Pole* |
|---|---|---|
| *Weight* | *475 lbs.* | *1,000 lbs.* |
| *Service Life* | *80 yr. (consistent performance)* | *20-50 yr. (declining performance)* |
| *Maintenance* | *None* | *5-7 years* |

*While NJDOT initially experienced hesitation from the utility companies when they were invited to participate in the PMP, continued outreach eventually produced an agreement for replacing and installing fiberglass poles when possible in accordance with the policy.*

## *REPORT CONCLUSIONS*

*Among other things, the FHWA report recommends placing utility poles and trees which are 4 inches in diameter or greater at a distance of at least 6 feet from the curb in urban areas. The report also refers to the AASHTO Roadside Design Guide for further guidance.*

APPENDIX F

# Example of Recommended Crash Reduction Program and Roadside Safety Treatments

*C. Paul Scott*

## *CRASH REDUCTION PROGRAM*

*A concentration of crashes at a site or in a small area, or a certain type of crash that seems to occur over and over in a given jurisdiction, may indicate that the highway/utility system is contributing to crash potential. Utility pole crashes are subject to the same types of crash patterns as other types of roadway crashes. They are thus subject to traditional highway crash study procedures. Detailed study of crash records may identify high-crash locations and point out improvements that will reduce the number and severity of future crashes. Road users can also provide input into the nature and causes of highway/utility crashes. The following steps are normally included in a comprehensive crash-reduction program:*

- *Setting up a traffic records system,*
- *Identifying high-crash locations,*
- *Analyzing high-crash locations,*
- *Correcting high-crash locations, and*
- *Reviewing the results of the program.*

*The size of the organization conducting the program has a great deal to do with its sophistication and complexity. Small highway agencies or utility companies may find it sufficient to place pins on a city map to identify high-crash locations and then review copies of police accident reports to select the best safety treatment. Large utility companies, units of local government, and highway agencies may resort to computers to handle enormous volumes of data. Crash reduction programs at this level frequently use sophisticated statistical software to select the best sites for treatment and to identify the most appropriate countermeasures.*

## *SETTING UP THE TRAFFIC RECORD SYSTEM*

*The first step is to gain access to crash data containing utility-specific information. Local government units and utility companies may need to visit the local law enforcement agency to discuss their proposed crash reduction programs and the types of data they will need to identify sites for further study. Once law enforcement officers are aware of the need to collect data on the number and types of utility devices involved in collisions,* *the availability of such data usually improves. Utilities may find it useful to compile their own files of crash information based on maintenance records of repair to damaged poles, observations of employees, or citizen input. For small utilities and small local governments, it may be sufficient to tabulate the crash information and to identify crashes on local street maps.*

*At the same time the crash data are being gathered, it may be appropriate to gather information on traffic volumes, speed limits (regulatory and advisory), roadway configurations, roadway and shoulder conditions, street or pavement widths, shoulder widths, right-of-way widths, pavement slopes and superelevation, distances of poles from the edge of pavement, locations of adjacent structures or trees, and other geometric data for sites where crashes have involved utility facilities.*

## *IDENTIFYING HIGH-CRASH LOCATIONS*

*A high-crash location is a site that has more crashes than similar sites with similar traffic volumes. There is never enough money to fix every site where crashes occur, so it is prudent to concentrate available funds on those sites most deserving of treatment. There are at least five ways to identify high-crash sites:*

*1. Number method: This is the simplest method. The number of crashes occurring at each site is identified, and the sites with the highest numbers become candidates for treatment. There is a critical weakness with this method. Sites with higher traffic volumes have a higher number of crashes. It may be normal for an intersection used by 50,000 cars a day to have 20 crashes in a year. However, it would be unusual for an intersection used by 200 cars a day to have the same number of crashes. This latter case might indicate a crash problem.*

*2. Rate method: This method overcomes the weakness of the number method by taking into account the number of vehicles passing each site. Crash rates are calculated and expressed as the number of crashes per million vehicles entering an intersection or per hundred million vehicle miles driven along a section of roadway. This method also has a crucial weakness. For very low-volume roadways, a single crash may produce a very high crash rate, which would be misleading.*

*3. Number–rate method: The user calculates the number of crashes and the crash rate. A site with high values in both categories is considered for further investigation. This overcomes the individual weaknesses of the number and the rate methods.*

*4. Rate–quality control method: This procedure uses statistical tests to determine whether the number of crashes, or the crash rate, at a specific site is above the systemwide average for similar sites.*

*5. Crash severity method: This method applies when sites are being evaluated. Several state transportation departments have incorporated this procedure. Each injury crash could be equivalent to x property-damage-only (PDO) crashes, and each fatal crash could be equivalent to y injury crashes. Thus, all the injury and fatality crashes at a site could be converted to the equivalent number of PDO crashes. Sites with severe injury and fatality patterns would have large conversions and would rank higher on the priority list.*

*The best procedure for a particular study depends largely on the size of the area being studied and the number of crashes that have occurred. For very small locations with few crashes, the number procedure may suffice. For statewide studies, the rate–quality control feature may be best. In each instance, the method chosen should determine whether the number of high-crash experiences is above desired limits and where analysis and safety treatments will do the most good for the public.*

## *ANALYZING HIGH-CRASH LOCATIONS*

*A site may be selected for further study because of the number, rate, or severity of utility pole collisions, or because it fits a pattern of sites that have been designated for systemwide improvements. After a site has been identified for further analysis, the analyst begins looking for patterns of crash types and causes. Once the pattern has been identified, appropriate treatments can be selected. The following steps are found in a typical site analysis:*

*1. Prepare a collision diagram (i.e., a sketch that uses arrows to show the types of collisions that are occurring). Such sketches may indicate poles too close to the roadway, poles that are hard for drivers to see, turning maneuvers that are too difficult for drivers to master, and similar factors that contribute to crashes.*

*2. Prepare a condition diagram (i.e., a scale drawing that shows the roadway geometry and any features that might have contributed to the crash). Typically, this diagram includes utility facilities, traffic control devices, street widths, intersection geometry, roadway grade or superelevation that may encourage vehicles to leave the traveled way when wet, and similar features.*

*3. Tabulate available data and look for patterns. Police accident reports can be used to tabulate type of fixed object (e.g., pole or tree), crash severity, day of week, time of day, weather conditions, and similar factors. Tabulating the time of day and pavement condition, for example, may reveal that most crashes happen at night. This pattern may be a clue that the utility poles are hard to see.*

*4. Visit the site. The analyst can visit the site to relate the findings from collision diagrams, condition diagrams, and tabulations. The observer may find poles too close to the road, poles on the outside of a curve, turning radii that are too sharp, high-speed traffic, and other characteristics that contribute to the crash pattern.*

*Sometimes these steps will identify a dominant crash pattern at a site, but often it is not so simple. There may be several crash patterns. Once the pattern or patterns are determined, it is usually possible to diagnose the cause of these patterns and to develop appropriate treatments.*

## *CORRECTING HIGH-CRASH LOCATIONS*

*For each high-crash location, several appropriate safety treatments may be available. Each alternative improvement is evaluated to determine its cost-effectiveness. This involves estimating the number of crashes that will be prevented by a certain treatment and then* *assigning cost savings due to decreased crash costs. Agencies such as the National Safety Council and the National Highway Traffic Safety Administration periodically publish estimates of crash costs. The cost savings are compared with the cost of installing and maintaining the improvement to generate a cost-effectiveness for the treatment.*

*Once all the alternatives have been evaluated, the most cost-effective treatment is selected. For a study of a large system, sophisticated computer programs may be used to identify the best sites and the most appropriate treatment at each site. The final step in selecting treatments is to set priorities. Treat those sites first that would do the most good for the public (i.e., prevent the most crashes, injuries, and fatalities). Highway agencies and utility companies are sometimes reluctant to identify sites that need safety treatment or to set priorities for treatment because of perceived liability. They may be afraid a list of high-crash sites could be used in court to show they were aware of crash problems but not concerned enough to do something about them.*

*Federal legislation has been adopted to help alleviate this problem. Title 23, United States Code, Section 409 (23 U.S.C. 409), prevents the "discovery" or admittance into evidence of most kinds of information gathered or used to identify sites as part of a safety program that utilizes federal-aid highway funds. The intent is to encourage safety programs by shielding the transportation department or utility company from spurious suits.*

### *REVIEWING THE CRASH REDUCTION PROGRAM*

*An important part of a crash reduction program is to determine whether previous treatments have worked. This involves periodic review of the sites after the treatments have been installed to make sure they have functioned as intended. Crash data may be collected to determine whether the number and severity of collisions have been reduced. A before-and-after study may be undertaken to make this determination.*

*Many publications are available to provide more complete information to guide highway agencies and utility companies interested in implementing crash reduction programs. Each state transportation department has a highway safety office or a traffic operations office that can help organize the program and provide pertinent publications, supply crash data, and otherwise contribute to a highway/utility crash reduction program.*

### *ROADSIDE SAFETY TREATMENTS*

*Ideally, the clear zone should be free of obstacles [clear zone is defined in the AASHTO Roadside Design Guide (1) as the total roadside border area, starting at the edge of the traveled way and extending a variable distance depending on traffic volumes, speeds, and roadway geometry]. Where these obstacles must be placed in the clear zone, or where an analysis has shown that an existing obstacle may need treatment, many options are available. The following list generally has been considered as the desirable order of treatment:*

- *Remove the obstacle.*
- *Relocate the obstacle where it is less likely to be struck.*

*• Reduce the number of poles.*
*• Reduce impact severity by using an appropriate breakaway device.*
*• Redirect a vehicle by shielding the obstacle with a longitudinal traffic barrier or crash cushion.*
*• Warn of the presence of the obstacle if the preceding alternatives are not appropriate.*

*These are general treatments, and many variations and combinations may be used. Researchers have identified the factors that contribute most substantially to crashes along utility pole lines. The most prevalent of these appear to be lateral clearance to the pole, volume of traffic, and pole density per mile. Lists of countermeasures have been developed to address these factors in utility pole crash problems.*

***KEEP THE VEHICLE ON THE ROADWAY***

*One obvious way to prevent utility pole crashes is to assist the driver in staying on the roadway. This may be done by positive guidance—for example, using pavement markings, delineators, advance warning signs, and other visual cues to tell the driver what to expect and to provide a visual path through a site. Physical enhancements such as improving the skid resistance of the pavement, widening the pavement travel lanes, widening or paving shoulders, improving the superelevation, straightening sharp curves, decreasing the speed of vehicles, and adding lighting in areas where crashes frequently occur at night may also diminish crash potential by decreasing the number of vehicles that for whatever reason leave the travelway.*

***UNDERGROUND UTILITY LINES***

*By burying utility lines, poles can be removed, greatly reducing crash potential. This alternative saves the utility company the costs of removing and replacing a pole damaged in a collision and of repairing the utility line after a crash. The primary disadvantage of this treatment is the additional initial expense. In addition, the line is now vulnerable to excavation damage, an additional connection may be necessary to provide reliable service, and the line is more difficult to patrol in the case of an outage. Even with underground utility lines, there still may be a need to safety treat ground surface pad-mounted transformers, switch cabinets, pedestals, and other associated hardware. When these devices are installed, they should conform to the applicable clear zone guidelines.*

*Underground installations are not the only acceptable treatment, and other types may be preferred for some sites. Rock formations, marsh, and similar site conditions may make underground treatment too expensive. It also may be difficult to handle unanticipated local growth, or it may be impossible to tap some underground facilities to add customers. In spite of these and other difficulties, an underground installation may be the best design solution. In some jurisdictions the utility may collect the incremental cost of placing an underground facility, particularly where overhead facilities are the basis for rates.*

### *INCREASED LATERAL OFFSET*

*Both crash rate and crash severity will decrease when utility poles are moved farther from the travelway. Ideally, the poles can be placed at the right-of-way line and outside the clear zone. Vertical construction can sometimes be used instead of cross-arm construction to provide more lateral clearance.*

*The full effectiveness of moving poles away from the roadway cannot be achieved if other fixed objects are allowed to remain in the clear zone. A utility pole crash reduction program should be part of a comprehensive plan that removes all types of objects from the clear recovery area.*

### *LOCATIONS LESS LIKELY TO BE STRUCK*

*There are many fewer off-road crashes on the inside of horizontal curves than on the outside. Consideration should be given to placing pole lines on the inside of curves. On winding roads, this placement may not be feasible, because the wires would have to cross the road each time sequential curves changed directions. For sharp curves, utility poles would need lateral bracing from compression struts or guy wires. With limited right-of-way, this might not be possible. Some state policies prohibit anchor guys between poles and the traveled way. Some jurisdictions prohibit compression struts. The alternatives include expensive self-supporting poles or anchor guys that extend into adjacent property if feasible and if permission can be obtained.*

*Where retaining walls, guardrails, non-traversable ditches, and similar features exist, pole lines can be placed behind them. Errant vehicles cannot travel past them to strike the poles.*

### *REDUCED NUMBER OF UTILITY POLES*

*An obvious way to decrease utility pole crashes is to decrease the number of poles beside the roadway. There are several methods available.*

- *Encourage joint use of existing poles, with one pole carrying streetlights, electric power, telephone, cable television, and other utility lines.*
- *Place poles on only one side of the street.*
- *Increase pole spacing by using bigger, taller poles.*
- *Selectively move poles away from hazardous locations.*

*Before any of these procedures is adopted, an engineering study should be conducted to determine whether the changes would be cost-effective and appropriate for the specific site. For example, increasing the spacing of poles requires that the remaining poles be larger and taller than the previous ones. These larger poles will be struck less frequently because there are fewer of them. However, the severity of the crashes may be greater because of their larger size and thus cancel any savings that might have accrued because of the decreased number of crashes.*

*Also, using bigger, taller poles is not a simple solution. In most cases, pole spacing is dictated by conductor size and characteristics and by codes and conductor spacing/clearance requirements. Some rules require that poles be placed at lateral property lines. Ideal span lengths for power poles may be too great for communication conductors. Typically joint-use spans are shorter than power line spans.*

*Removing or relocating a few poles in areas of high hazard may be used as a treatment after several crashes have occurred. This countermeasure requires no formal economic analysis and may be particularly appropriate in rural areas.*

## *BREAKAWAY DEVICES*

*When a pole must remain in place, it can be modified to break away upon impact and swing out of the path of the vehicle, reducing the severity of the crash. Breakaway sign supports and breakaway luminaire supports have been used for many years. Breakaway timber utility poles have been made available through research conducted for the Insurance Institute for Highway Safety in the 1970s and for FHWA in the early 1980s. Breakaway utility poles cannot be used at every location, but there are instances and circumstances for which they may be the most appropriate crash reduction treatment. Guy wires for utility poles can also cause crashes. They snag and flip vehicles that strike them and can cause severe injuries to cyclists. Guy wires that are closer to the traveled way than the structure they support should be avoided. Research is being conducted to develop a breakaway guy wire coupling.*

## *ROADSIDE BARRIERS AND CRASH CUSHIONS*

*If it is not feasible or practical to remove utility structures, move them, or place them underground, then other treatments may be necessary. One type of acceptable treatment is to shield the vehicle from striking the fixed object. Roadside barriers perform this function by redirecting the vehicle away from the utility structure, allowing the driver an opportunity to recover control of the vehicle. The AASHTO Roadside Design Guide (1) may be used to determine whether a roadside barrier is an appropriate treatment and, if so, what design is suitable for site conditions.*

*A roadside barrier is a longitudinal system used to shield motorists from natural or man-made hazards located along either side of a roadway. There are instances in which a roadside barrier is not appropriate. One example involves flexible and semirigid barrier systems when there is not enough room between the barrier and the fixed object for the barrier to fully deflect during impact. Also, a roadside barrier should be placed as far from the traveled way as conditions permit. Other helpful design information can be found in the Roadside Design Guide (1).*

*Another way to shield a vehicle from striking a utility pole is to use a crash cushion, which functions by collapsing upon impact and slowing the vehicle at a controlled rate. A crash cushion is normally used where there is an isolated fixed object hazard. If there are several objects, a roadside barrier is probably a better safety device. Crash cushions typically are much more expensive than roadside barriers.*

*Crash cushion design is more complex than barrier design. The type of crash cushion and its dimensions must be designed to fit site conditions and to absorb energy (from the impacting vehicle) at the appropriate rate. The Roadside Design Guide (1) is the source of information for the design process.*

*Roadside barriers and crash cushions should not be used indiscriminately for at least two reasons: they are expensive to install and to maintain, and they are closer to the road than the objects they are shielding. They are involved in more crashes than unshielded objects. They should be used only when they are warranted to reduce crash severity.*

## *WARNING THE MOTORIST OF THE OBSTACLE*

*The number of crashes or the severity of crashes may be decreased by warning motorists of the presence of poles adjacent to the roadway. This may be done with warning signs, reflective paint, sheeting, object markers placed on utility poles, and roadway lighting. Poles on the outside of a horizontal curve, where a lane becomes narrow, at the end of a lane drop, and in other locations where vehicles are likely to travel close to them are candidates for such warning where more comprehensive treatments are not justified.*

## *SELECTING COUNTERMEASURES*

*The method used for selecting countermeasures depends on the size and complexity of the project. For an individual site, the selection may be made through the judgment of an informed individual or a group of individuals. For a systemwide project or for a series of sites, the decision may be based on a cost–benefit analysis or a sophisticated, computer-aided optimization procedure. There is also a methodology specifically designed by FHWA for utility pole treatment determinations.*

## *DIAGNOSTIC REVIEW TEAM*

*The experience of several agencies and the knowledge of informed parties may be brought together to review a crash problem at a particular site. State transportation departments do this routinely as part of the Federal-Aid Highway Safety Improvement Program. Once a site has been identified for investigation and possible treatment, a diagnostic review team is appointed. The composition of the team is matched to the particular problem. For utility poles, FHWA encourages state, utility company, and FHWA representatives to work together to identify hazardous sites and evaluate the various countermeasures being considered. Utility staff members should be invited to join field reviews. They may be able to supply information about the planned upgrading of the utility line, replacement options, and alternative designs that would assist in making a decision about the most appropriate countermeasures.*

*Whenever possible, utility corrective work should be handled in conjunction with highway or utility upgrading and during utility rehabilitation projects to minimize the overall cost of the program. Typical results of a field review are a series of recommendations for potential treatments. For small projects, there may be only one or two recommendations. For large projects, the recommendations may be complex and require further analysis.*

## *COST-EFFECTIVENESS STUDY*

*The second procedure for selecting countermeasures is to perform a cost-effectiveness analysis. This involves comparing the costs of various treatments to determine the most effective use of limited funding. Costs include items such as potential future crashes, initial construction costs, ongoing maintenance, and similar items. Benefits include a reduction in the number of crashes with a commensurate savings of crash costs, reduced maintenance costs, possible savings in travel time for motorists, and the salvage value of the facility at the end of the useful service life.*

*The time value of money is considered by applying the net present worth procedure (or a similar method) to the costs and benefits. Benefits and costs are compared to determine whether an improvement is cost-effective and to set priorities among the many projects competing for limited highway funds for safety improvements.*
*The appendix of the Roadside Design Guide (1) contains a good cost-effectiveness methodology. Example calculations are provided to illustrate the methodology. This procedure has also been adapted to the computer. Instructions about ordering the software for the cost-effectiveness procedure may be found in the Roadside Design Guide (1).*

*For large projects or for a statewide crash reduction program, comprehensive computer programs perform many of the calculations. They also may use advanced statistical techniques to optimize funding and to produce master lists of acceptable projects.*

## *UTILITY POLE COST-EFFECTIVENESS PROCEDURE*

*Zegeer and Parker (2) developed a cost-effectiveness procedure specifically for selecting utility pole countermeasures. This methodology was published as an FHWA report, which is full of tables, graphs, and charts that can predict the number of traffic crashes involving utility poles of different configurations. Once an agency has decided to undertake a treatment program, it can use this methodology to test alternative designs to see which yields the most cost-effective treatment.*

*This procedure normally requires a field inspection program to gather the data necessary to perform the methodology. The FHWA report provides data sheets for this purpose, along with step-by-step instructions for performing the field inventory.*
*A research project conducted for FHWA developed a computerized version of the utility pole cost-effectiveness model. This program was called UPACE. It performs the*

*drudgery of calculating the anticipated number of crashes; making adjustments for the various types of crashes in the clear zone; and estimating the expected cost of treatment, expected total reduction in crashes, expected cost savings, and other predictions needed to evaluate the effect of the treatment. The software is now marketed by the McTrans Center in the Civil Engineering Department at the University of Florida.*

## *BEST METHOD*

*There is no such thing as a method that is always the best. The best method for selecting countermeasures depends on local conditions, size of the program, funds available, and other factors.*

## *REFERENCES*

*1. Roadside Design Guide. AASHTO, Washington, D.C., 1996.*
*2. Zegeer, C. V., and M. R. Parker, Jr. Cost-Effectiveness of Countermeasures for Utility Pole Accidents. FHWA Report FHWA/RD-83/063 8009/8209; HS-037 308, FHWA, 1985.*

APPENDIX G

# Examples of STA Guidelines with Safety Implications

1. **GEORGIA DOT**
2. **NEW JERSEY DOT**
3. **WASHINGTON STATE DOT**

DIVISION OF OPERATIONS

OFFICE OF UTILITIES

GDOT
Georgia Department of Transportation

# Utility Accommodation Policy and Standards

## 2016

Utility Accommodation Policy and Standards Manual 2016
Revised: 12/01/2018

**Atlanta, Georgia**

# CHAPTER 8: UTILITY POLE SAFETY PROGRAM

## 8.0. GENERAL

The Department has the responsibility to work with pole owners to develop and implement programs to systematically remove, relocate, or mitigate hazardously located utility poles in a reasonable, cost-effective manner as per the provisions of 23 CFR Part 645.209(k).

The Utility Pole Safety Program sets guidelines to reduce the potential for pole crashes and assist Utility companies, State, and Local transportation professionals in targeting the most hazardous poles for removal/relocation/mitigation. The cost to relocate poles is staggering. However, it is conservatively estimated that an appropriately funded program will yield very cost effective safety improvements. The safety improvements concept is based strictly on the probability that a crash will be reduced based on the further an object is from the roadway (see Chart 8-1).

### Reduction Due to Increasing Lateral Pole Offset

| Pole Offset Before Relocation (ft) (1) | Expected Reduction in Utility Pole Crashes (Reduction Factor) (2) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pole Offset After Relocation (feet) (3) | | | | | | | | | | | | | |
| | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 20-30 |
| 1 | 0.87 | 0.88 | 0.89 | 0.90 | 0.90 | 0.91 | 0.92 | 0.93 | 0.94 | 0.95 | 0.95 | 0.97 | 0.97 | 0.98 |
| 2 | | 0.75 | 0.76 | 0.77 | 0.79 | 0.80 | 0.82 | 0.83 | 0.84 | 0.87 | 0.88 | 0.90 | 0.90 | 0.92 |
| 3 | | | 0.63 | 0.65 | 0.67 | 0.69 | 0.71 | 0.73 | 0.75 | 0.79 | 0.80 | 0.82 | 0.83 | 0.85 |
| 4 | | | | 0.4 | 0.42 | 0.5 | 0.55 | 0.6 | 0.63 | 0.69 | 0.7 | 0.72 | 0.73 | 0.77 |
| 5 | | | | | 0.4 | 0.4 | 0.5 | 0.56 | 0.59 | 0.65 | 0.67 | 0.69 | 0.7 | 0.74 |
| 6 | | | | | | 0.3 | 0.36 | 0.43 | 0.48 | 0.55 | 0.57 | 0.6 | 0.62 | 0.67 |
| 7 | | | | | | | 0.22 | 0.31 | 0.37 | 0.46 | 0.48 | 0.52 | 0.54 | 0.59 |
| 8 | | | | | | | | 0.22 | 0.29 | 0.39 | 0.42 | 0.45 | 0.48 | 0.55 |
| 9 | | | | | | | | | 0.18 | 0.3 | 0.33 | 0.37 | 0.4 | 0.48 |
| 10 | | | | | | | | | | 0.22 | 0.25 | 0.3 | 0.33 | 0.42 |
| 11 | | | | | | | | | | | 0.18 | 0.24 | 0.27 | 0.36 |
| 12 | | | | | | | | | | | | 0.11 | 0.15 | 0.25 |
| 13 | | | | | | | | | | | | | 0.11 | 0.22 |
| 14 | | | | | | | | | | | | | | 0.17 |

Source: Federal Highway Administration. Report Number FHWA/RD-82. Volume II. Final Report. "Cost-Effectiveness of Countermeasures for Utility Pole Crashes." Washington: January 1983. Page 82. Table 23.

(1) Distance from edge of pavement to existing face of pole
(2) Reduction of Utility Pole Crashes resulting from relocation
(3) Distance from edge of pavement to new pole location

***Example:*** If the existing pole is to be relocated from 4 feet to 10 feet, you can expect a 60% reduction in the number of Utility Pole Crashes.

**Chart 8-1**

## 8.1 FUNDAMENTALS

**8.1.A. Objective** - This multifaceted approach includes treating isolated problem locations and high risk sites, as well as preventing the development of new high risk sites, and includes systematic reviews and treats high risk corridors. This is generally a long range, systemic approach that requires steady and consistent application to ensure effective use of the time and cost involved to meet this objective. The opportunities for application range from initial design of new facilities, road widening projects, and utility rehabilitation, to even smaller projects such as those where turn lanes are built by developers with private funding.

**8.1.B. Goals** - While removing all utility poles is preferable in order to reduce the number and potential for future utility pole crashes, in some cases, it may not be feasible to remove or relocate all existing utility poles from the clear zone. However, it may be possible to lessen the risk of a future pole crash by utilizing the following Four Key Plan Elements. These Four Key Plan Elements help identify locations that will be part of the Department's permitting and safety efforts. It does not expand or allow poles to be located in areas previously prohibited, such as limited access, medians, gore areas, etc. These Key Plan Elements will apply in curb and gutter and rural shoulder sections and apply to any above ground fixed utility object sufficient to cause serious damage upon impact by an errant vehicle.

**Four Key Plan Elements**

1. **Crash Data** - This element addresses the locations that have crash problems or are recognized as high risk locations. The application of this key element is limited to a single pole or a few poles. This element will be addressed by increasing the Utility Industry's awareness of fatal crashes that involve utility poles by reviewing crash reports with pole owners.
2. **Relocation** - This element targets specific poles located in 3 mile sections. The sections will have a history of pole crashes (responsive), or are in locations where the risk of future pole crashes is likely (pro-active). The mechanism for identifying the locations will be through the utility pole crash database. In a joint effort the Department will use Safety Funds (when available) to assist Utility Companies with the relocation or mitigation of the poles.
3. **Existing Facilities** - This element involves developing and implementing policies that prevent placing (or replacing) poles within the clear zone area along streets and highways during betterment, rehabilitation or reconstruction of existing Utility facilities. This element will require a two-pronged approach: first, a categorization, which will be based on

utility poles having crash history in certain sections of areas being rehabilitated; and, second, a determination, which will be based on the number of poles being added or replaced on the rehabilitated section.

4. **New Facilities** - This last element will address all new requests for Utility facilities involving utility poles on State Right-of-Way. All provisions of this Manual and/or the AASHTO *Roadside Design Guide*, current edition, will be utilized for an effective permit process that prevents the installation of utility poles in hazardous locations.

## 8.2 REQUIREMENTS

The Department, in a joint effort with the GUCC, has endeavored to develop policies to help reduce crashes involving utility poles. The Department and the Utilities have considered several alternatives for treating high crash locations. To attend to the four Key Plan Elements listed above to help prevent future installations and/or remove existing utility poles in current hazardous locations, the Department will address and/or review utility permit requests with the following requirements:

**8.2.A. Crash Data** - The State Utilities Office will review all crash reports involving utility poles when a fatality occurs. If the utility pole is a primary factor in the crash, the State Utilities Office will then notify the pole owner that a site visit may be required. Upon performing the site visit, the pole owner and the State Utilities Office will formulate a Relocation or Mitigation Plan for the pole or poles for the area in question.

**8.2.B. Relocation** – This is a proactive effort by participating Utilities to address high crash locations within their service area. The Department may assist in funding relocation of poles based on crash data for selected utility projects when safety funds are available. The Department will review crash data of high risk locations based on the crash history as determined by the utility pole crash database. Then, a 3 mile section of a State Highway will be selected in which a utility project will be programmed and funding provided on a 50/50 cost ratio. Agreements will be eligible for reimbursement under the classification for Case V and shall be prepared in accordance with Chapter 4 of this Manual.

After a utility project is programmed, the Utility Companies and the State Utilities Office will conduct a site inspection along the selected 3 mile section. An assessment will then be made, jointly, to determine whether or not relocating utility poles along this selected route will improve the overall safety.

If the route has a variety of obstacles, such as buildings and trees in addition to the pole line, the project may be referred to the District Traffic Operations Office for consideration as a "corridor improvement project". The State Utilities Office will then select the next project for consideration from the Utility Pole Crash Database. These efforts target existing poles found in hazardous locations which would see a measurable improvement of safety by relocating the poles, and where, in these cases, the poles are necessary and there are no alternatives to serve the purpose of the poles. The utility projects selected shall be in locations that have a history of pole crashes, where the risk of future pole crashes are likely, and where the safety on the route would improve drastically by relocating the existing poles.

**8.2.C. Existing Facilities** - All existing utility facilities located on State Highways shall be allowed to stay in their current location, unless, as part of a Utility betterment, rehabilitation or reconstruction of existing facilities, the utility permit for the facility shall be reviewed to verify if one of the following two conditions exist:

**8.2.C.1. Major Rehabilitation or Reconstruction (Category 1)** - If a major betterment, rehabilitation, or reconstruction project is being performed by the Utility pole owner, and a net total **equal to or greater than 33%** of the total number of poles that are being affected or planned to be replaced, or additional poles are being added due to larger wire diameter and/or distance requirements, or taller poles are being installed for additional utility clearance requirements, the Utility shall be required to relocate all the poles in the permit request to meet current clear roadside requirements shown in this Manual, current edition and/or the AASHTO *Roadside Design Guide*, current edition. Projects of two poles or less are exempt from this requirement. (See Table 8.2.C below).

**8.2.C.2. Major Rehabilitation or Reconstruction (Category 2 )** - If a major betterment, rehabilitation, or reconstruction project is being performed by the Utility pole owner, and a net total of **less than 33%** of the total number of poles that are affected or planned to be replaced, or additional poles are being added due to larger wire diameter and/or distance requirements, or taller poles are being installed for additional utility clearance requirements, the project route will be reviewed for crash history. Where crash data for the pole line in question shows an average of one crash per mile per year for the last three (3) years of data available, and where the existing pole locations do not meet the current clear zone requirements, the pole owner will be required to relocate the section of poles or use approved mitigation methods. (See Table 8.2.C below)

| Total Number of Poles being Added or Replaced | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Total Number of Poles on Project (Along GDOT roadway) | 1 | *Exempt | -- | -- | -- | -- | -- |
| | 2 | *Exempt | *Exempt | -- | -- | -- | -- |
| | 3 | *Exempt | *Exempt | MMC | -- | -- | -- |
| | 4 | *Exempt | *Exempt | MMC | MMC | -- | -- |
| | 5 | *Exempt | *Exempt | MMC | MMC | MMC | -- |
| | 6 | *Exempt | *Exempt | MMC | MMC | MMC | MMC |
| | 7 | *Exempt | *Exempt | MMC | MMC | MMC | MMC |
| | 8 | *Exempt | *Exempt | MMC | MMC | MMC | MMC |
| | 9 | *Exempt | *Exempt | MMC | MMC | MMC | MMC |
| | 10 | *Exempt | *Exempt | *Exempt | MMC | MMC | MMC |

Table 8.2.C: Note: ***Exempt*** means able to retain poles in existing location (*crash data evaluation required) and ***MMC*** means poles Must Meet Clearzone. Only mainline poles along the GDOT roadway are to be included in the total number of poles for this calculation.

This table is not all inclusive; if a project exceeds examples above use Sections 8.2.C.1 or 8.2.C.2 as applicable.

**8.2.D. New Facilities -** All new utility facilities permitted for installation on right-of-way shall be required to meet current clear zone requirements as shown in this Manual, current edition and/or the AASHTO *Roadside Design Guide*, current edition. Permissible locations and standards for these installations are included in Chapter 5 of this Manual.

## 8.3 MITIGATION POSSIBILITIES

The most desirable design solution, in terms of roadside safety, is to use as few poles as is practical and to locate the utility poles where they are least likely to be struck by a vehicle. Even so, there will be locations where the Utility and the Department agree there is no feasible way to accomplish this goal and other countermeasures must be considered to mitigate or reduce the number and severity of crashes with utility poles and above ground utility appurtenances. The following are some options that should be consider:

A. **Increase Pole Spacing -** The spacing between utility poles differs depending upon the type of utility and the general practices of the specific company, but should be maximized where possible. As poles are placed farther apart, the openings that will allow a vehicle to pass through without striking a pole become larger. When placing service poles (either short side or long side connections) for an individual or company, the service pole should be placed off the right-of-way with the actual service connection being made to an existing pole. The placing of mid-span poles and service poles just behind the pole line should be discouraged.

B. **Combine Pole Usage with Multiple Utilities** - Although the Department's current policies dictate a single pole line, they cannot stipulate that poles be placed off the right-of-way (some conditions may prohibit the distance from right-of-way). If a pole line exists on the right-of-way, efforts should be made between the Utilities to either relocate the existing line with the new facility or rebuild the current facility to accommodate both facilities.

C. **Bury Electric and Telecommunication** - As pertaining to electrical lines, rarely would burying the facility be proven to be a cost effective solution to existing facilities, but may be justified in new design or for aesthetic considerations. As for telecommunication facilities, burying the facility underground is an option that should be approached to remove pole lines in hazardous locations.

D. **Change Pole Position** - Although the most direct solution is to remove the utility pole or poles, this is often not practical, but relocating the pole(s) to a location where they are less likely to be struck should be encouraged. Each site may give natural locations to which a pole(s) can be located (e.g., behind a ditch, existing guardrail, up a slope or on the inside of a curve). These natural or pre-existing locations should be utilized to reduce impacts.

E. **Breakaway Poles** - The application of breakaway devices is a strategy directed at reducing the severity of the pole crash. The unforgiving nature of a utility pole contributes to the severity of the crash by causing vehicles to rapidly decelerate. Breakaway poles allow the vehicles to pass through the pole and, therefore, the vehicle will not absorb as much energy. While there are several designs and techniques for breakaway devices, only the Steel Reinforced Safety Pole was specifically designed for utility poles. Some of the criteria for use of a breakaway device are that the pole is a class 4-40 or smaller and does not have heavy devices attached. There is a safe recovery area behind this type of pole so that the pole(s) is not located near a zone of significant pedestrian traffic which, if the pole(s) was hit, would create a hazard for pedestrians, other vehicles, and adjacent property owners. The Utility shall be responsible for the determination of the use of breakaway poles.

F. **Guardrail** – The purpose of guardrail is to redirect errant vehicles away from a roadside hazard so drivers may regain control of the vehicle or arrive at a safer stop than what would be provided by striking the hazard. Shielding drivers from poles is a proper use of guardrail when the alternatives for removing and/or relocating the poles are not practical due to right-of-way constraints, roadside environment, or economics. The guardrail and the end treatments or barrier should not create a greater hazard than the pole and will prevent vehicles from being redirected into a more hazardous roadside area or situation.

G. **Crash Cushions** - Crash cushions ranging from simple effective sand-filled barrels to more sophisticated devices are available. Where space is available, sand-filled barrels are cost effective solution, but will need to be maintained by the Utility.

H. **Warning Motorists of Obstacles** – The number of crashes and the severity of crashes may sometimes be decreased by warning motorists of the presence of poles adjacent to the roadway. This may be done with warning signs, reflective paint, object markers placed on utility poles, or roadway lighting. It is considered a last resort in some cases where more comprehensive treatments are not practical.

## 8.4 EXCEPTIONS FOR EXISTING & NEW FACILITIES

Conditions may arise or exist in the field that make it impractical or cost preventive to comply with a particular policy or standard. Where compliance with a policy or standard is impractical, an "Exception" must be obtained. Exceptions are not to be interpreted as compromising safety or quality. Where the Utility feels that the normal policies or standards are not practical, the Utility bears the responsibility of demonstrating that alternative treatments are more appropriate. This must first be accomplished by demonstrating to the District Utilities Engineer that an exception is warranted. If the District Utilities Engineer feels that an exception should be granted, a formal written request, including all of the appropriate documentation, plans, and complete permit application, will be sent to the State Utilities Office stating the recommendation. This information should clearly indicate the exact exception that is being requested (i.e. what condition does not meet the minimum criteria set forth in this Manual or the AASHTO *Roadside Design Guide*) and what alternative action is being proposed. The request shall then be reviewed by the State Utilities Engineer for approval or denial. If the exception is denied by either the District Utilities Engineer or the State Utilities Engineer and, in the opinion of the Utility, alternates are not feasible, and then the Utility may appeal the denial to the GUCC Clear Roadside Committee (CRC) for review. The Committee will review the Utility Companies exception request and make a recommendation to the Department for a final ruling. If federal funds are involved, the Department will refer to the FHWA for review and approval of any exception request.

## 8.5 PARTICIPATION

The Department encourages Utilities with existing aerial facilities to participate in the Utility Pole Safety Program by signing an Memorandum of Understanding stating that they will participate in all of the Four Key Plan Elements that have been agreed to between the GUCC and the Department for their utility facilities in their service area, and/or stating that they will transfer their facilities in a timely manner. In the event the Utility elects not to participate in the Utility Pole Safety Program, all future permit requests shall meet the current clear roadside requirements set forth in this Manual or the AASHTO *Roadside Design Guide*, current edition.

## NEW JERSEY ADMINISTRATIVE CODE

## TITLE 16. TRANSPORTATION

## CHAPTER 25. UTILITY ACCOMMODATION
**(Expires on February 1, 2023)**

## SUBCHAPTER 10, OVERHEAD POWER AND COMMUNICATION LINES

16:25-10.1 General provisions

(a) Ground-mounted utility facilities shall be placed as far as practical from the traveled way and as near as practical to the right-of-way line and are restricted in certain locations as follows:

1. No above ground facilities shall be located within grade separated interchange areas of limited access highways.

2. No aerial crossing of limited access highway right-of-way shall be permitted with the exception of electrical facilities operating at a potential of 26 KV or above.

(b) When replacing an existing pole, the utility shall remove the existing pole within 90 calendar days following installation of the new pole.

(c) For Department projects, upon approval of the Utility Owner Design Authorization, the Department will consider acquiring pole guy property rights at critical locations if the utility has identified proposed guy easement locations in advance, so as not to interfere with the project's right-of-way acquisition schedule.

16:25-10.2 Installation standards

(a) Installation of overhead lines on highway right-of-way shall be limited to single wooden pole type of construction unless a waiver is approved by the Department pursuant to N.J.A.C. 16:25-13.3.

(b) Use of non-wooden poles requires Department approval of a waiver, pursuant to

N.J.A.C. 16:25-13.3.

(c) Installation of non-wooden poles approved by the Department pursuant to a waiver shall comply with the provisions of this chapter.

(d) At locations where more than one utility or type of facility is involved, every effort should be made to limit utility poles to one side of the highway with joint usage, as indicated by Rule 222 of the National Electrical Safety Code. This is of particular significance at locations where the right-of-way widths approach the minimum needed for safe operation or maintenance requirements or where separate installations may require extensive removal or alteration of trees.

(e) Utility pole delineators are reflective markers placed on utility poles that provide the driver of a vehicle with the alignment of the roadway and the location of the pole by their reflection of the car's lights during nighttime hours of sunset to sunrise. Utility pole delineators shall be placed on relocated poles and poles involving new utility installation at locations vulnerable to vehicular impact, such as islands, gore areas, outside of horizontal curves, and critical locations described in N.J.A.C. 16:25-10.3(d) and (*o*). Existing utility poles with a history of multiple vehicular hits shall be furnished with delineators as part of the maintenance or replacement process.

(f) Utility companies shall be responsible to meet the Department's standard highway lighting power source requirements. For utility company owned lighting designated to provide lighting for the State highway, the utility companies shall be responsible to meet the Department's standard highway lighting requirements by furnishing, installing, and maintaining highway lighting fixtures approved by the Department with appropriate power supplies. All highway lighting requirements shall be developed in consultation with the utility. Standard lighting on new utility pole installations shall be installed in a reserved area at a pole height of approximately 26 feet.

(g) Pole attached utility components including, but not limited to, solar panels, antennas, and cameras, shall be positioned within the designated zone for the respective utility.

16:25-10.3 Location and alignment

(a) Utility poles shall be located as close to the right-of-way as practical, preferably no further than five feet from the right-of-way line as allowed by cross-arm aerial clearance requirements. Aerial easements shall be considered to accommodate cross-arms to achieve the desired pole offsets.

(b) Location of overhead utilities on highways with narrow right-of-way or on urban streets with closely abutting improvements requires special consideration. Utility poles shall be located behind the sidewalk, as far as practical from the curb or gutter line. When this is not feasible, poles may be placed between the sidewalk and the curb or gutter line, as close to the sidewalk as possible. If site constraints require utility poles to be placed within the sidewalk area, they shall be located in compliance with the Department's Roadway Design Manual by maintaining the minimum useable width of sidewalk to allow for wheelchair passage. In no case shall the face of the utility poles be located closer than 1.5 feet from the face of the curb or the gutter line.

(c) The distance between utility poles should be the longest feasible span length consistent with geometric and design line loading considerations.

(d) In areas where advisory speed, speed reduction, and/or horizontal alignment warning signs are posted in advance of highway curves, consideration shall be given to relocating the poles to the inside of the curve, installing the facility underground, or some other cost effective alternative, which avoids the placement of poles on the out- side of the curve. Should pole placement be required along the outside of the horizontal curve, the number of poles shall be held to a minimum and pole offsets shall be increased to the maximum allowable given the site constraints.

(e) Where a guide rail is present, utility poles shall be located in accordance with the Department's Roadway Design Manual.

(f) Utility poles shall be located longitudinally at least 50 feet beyond an exit terminal or gore/island approach end. Placement of poles in islands that do not have a longitudinal through roadway length of 100 feet or more is discouraged, except where other locations are unusually difficult and unreasonably costly.

(g) Poles being installed in proximity to a bridge structure shall maintain a minimum offset distance equal to or greater than the exposed height of the pole.

(h) Guy wires to ground anchors and stub poles shall not be placed between a pole and the traveled way where they encroach upon the clear zone area. Push brace poles shall not be placed between the utility pole and the traveled way.

(i) Where irregular shaped portions of the right-of-way extend beyond the parallel right-of-way limits, variances in the location from the right-of-way line may be al- lowed, as necessary, to maintain a reasonably uniform alignment for longitudinal overhead installations.

(j) Poles, guys, or other related facilities shall not be located in a highway median unless other alternatives are determined to be impractical and where suitable protection is provided to the highway user.

(k) At locations where a traffic signal standard, traffic signal standard mounted lighting assembly, separate lighting standard, or overhead sign structures exists, the installation shall conform to the provisions of N.J.A.C. 16:25-10.4.

(l) When electrical facilities (26 KV and above) are approved for installation across limited access highway right-of-way in accordance with N.J.A.C. 16:25-12, they shall be installed in accordance with the criteria set forth in this chapter; however, the proximity criteria used shall take into account not only existing highway facilities such as light standards and sign supports, but also facilities that the Department proposes within the area where the utility crossing will be constructed.

(m) To the greatest extent possible, utility poles should be located longitudinally along the roadway. Aerial crossings over roadways should be minimized and longitudinal aerial spans over roadways should be avoided.

(n) Placement of utility poles, guys, or other utility related facilities within intersection corner quadrants should be avoided. If utility poles are required at an intersection, pole placement should be designed to avoid the most crash vulnerable locations involving potential secondary collisions (collision of a vehicle with a pole resulting from an initial two vehicle collision).

(o) The placement of poles shall be avoided at critical locations, such as lane drops, deceleration lanes, "T" intersections, and sections where the pavement narrows. If it is impractical to span these areas, the Department may approve locating the pole in the area least vulnerable to vehicular impact.

16:25-10.4 Clearance requirements

(a) The minimum clearances for overhead power and communication lines shall in no case be less than the standards prescribed by the National Electrical Safety Code (NESC).

(b) When rebuilding an existing pole line or constructing a new pole line at locations where there are no traffic signal standards, lighting standards, or overhead sign structures, poles of not less than 40 feet in overall length shall be installed and the attached primary line, at its lowest point, shall have a minimum clearance of 30 feet from the ground.

(c) At locations where the Department has identified a future need to install new or upgraded traffic signal standards, lighting standards, or sign structures, poles of not less than 50 feet in overall length shall be installed.

(d) The minimum clearances between overhead power lines and highway traffic signals, traffic signal pole mounted lighting arms, cameras, antennas, other appurtenances, or lighting standards shall be determined as follows. Voltages are measured phase to ground.
Minimum Clearances

| Power Line Voltages | Lateral | Vertical |
|---|---|---|
| 0-750 volts | NESC | NESC |
| 750 volts-50 KV | NESC or 10 feet, | NESC or 10 feet, |
| whichever is greater | whichever is greater | |
| Above 50 KV | NESC or 10 feet, plus | NESC or 10 feet, plus |
| 0.4 inches per kilovolt | 0.4 inches per kilovolt | |

# WASHINGTON STATE GUIDELINES

## Chapter 9 Control Zone Guidelines



### 900.01 General

*Washington State's Strategic Highway Safety Plan* (SHSP) establishes strategies to reduce traffic fatalities and serious injuries along state highways, and identifies utility objects, specifically utility poles, as significant roadside hazards. This chapter addresses the objective of eliminating utility object collisions in accordance with the SHSP and provides guidance on the placement of aboveground utilities within Washington State Department of Transportation (WSDOT) highway rights of way. Further information regarding the SHSP can be found at: http://targetzero.com/pdf/targetzeroplan.pdf

### 900.02 Clear Zone vs. Control Zone

Clear Zone is defined in the WSDOT *Design Manual* as "The total roadside border area, available for use by errant vehicles, starting at the edge of the traveled way and oriented from the outside or inside shoulder (in median applications) as applicable…"

From a technical standpoint, Control Zone and Clear Zone are synonymous in that the criteria and methodology used to calculate the two are identical. The distinction is one of policy in applying measures to achieve compliance. The differing policies are based on the recognition that accommodation of utility facilities within the state highway right of way is in the public interest when such use and occupancy do not adversely affect highway operations or safety. Control Zone Policy recognizes that practicable options for utility accommodation are sometimes limited to the right of way under WSDOT's control and allows for certain measures, including variance approvals of utility objects, with due consideration for the safety of highway users.

It is critical for WSDOT staff to work cooperatively with the utilities in implementing these guidelines during both accommodation and project delivery coordination, including helping utilities to understand the methodologies involved with Control Zone calculation and ensuring any necessary corrective action or other remedies specified in this chapter are implemented.

## 900.03 Control Zone Objective

The primary objective under WSDOT's Control Zone Policy is for all utility objects to be located outside of the Control Zone.

It is not always possible for utilities to achieve this objective for reasons that include physical/topographic limitations and unjustifiably high costs associated with relocating or undergrounding lines. Because of this, Control Zone Policy allows for authorizing variances for individual utility objects when justification can be demonstrated. These processes and criteria are described in 900.11.

## 900.04 Definitions

See Appendix A, Glossary.

## 900.05 Application

All new utility objects will be constructed outside the Control Zone unless a variance is authorized. In addition, utilities will be required to relocate or mitigate existing objects within the Control Zone by addressing existing objects during WSDOT highway projects, utility reconstruction, and Franchise Renewal/Consolidation, or if the department determines that any existing objects must be relocated or mitigated for the safety of highway users.

### *(1) Utility Construction or Reconstruction*

During utility construction or reconstruction, the utility will locate or relocate all utility objects to outside the Control Zone unless they are classified as Location III Objects or a variance is granted.

### *(2) Highway Improvement Projects*

During the planning phase of state highway improvement projects, WSDOT will inform the utility that it is required to adjust utility objects that, either prior to or as the result of the project, are located in the Control Zone. For WSDOT highway safety projects (such as I2 projects), additional relocation or mitigation for objects outside the Control Zone may be necessary. In these cases, WSDOT will work with the utilities and adjoining property owners to determine available options and coordinate any necessary corrective action.

WSDOT will notify the utilities of upcoming highway improvement projects as early as possible. During the project development phase, the utility will be advised of the scheduled project advertising date and of those utility objects requiring relocation.

### *(3) Franchise Renewal and Consolidation*

Prior to renewal or consolidation of franchises that include aboveground utility objects, the utility shall identify all Location I and Location II Objects within the proposed Franchise Renewal or Consolidation and submit a Corrective Action Plan and schedule of relocation, reclassification, or countermeasures for WSDOT review and approval. It is expected that a utility company will budget resources to accomplish the work necessary to renew franchise documents, including bringing its facilities in compliance with Control Zone requirements.

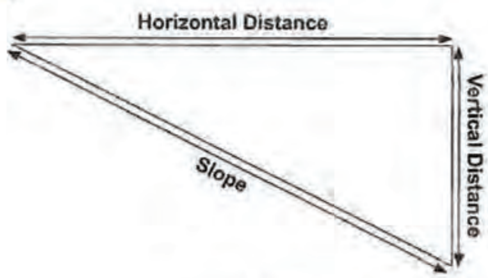
## 900.06 Control Zone Distance

The Control Zone distance for any particular highway segment varies according to the posted speed, traffic volumes, and sideslopes of the highway. This section contains methods and supporting information on determining the Control Zone distance for a particular location along the highway, including:

- General guidance for determining Control Zone distance.
- Different methods of Control Zone calculation and examples applicable to various highway geometric conditions (Conditions 1 through 6).
- Clear Zone Distance Table (see Figure 900-9) to be utilized in Control Zone calculation.
- Recovery Area Formula for use with Conditions 4 and 6.

### *(1) General Guidance for Determining Control Zone Distance*

- All distances are measured from the edge of the through lane, extending outward perpendicular to the traveled way.
- Roadside is the distance measured from the edge of the through lane to the beginning of the backslope, as in Conditions 2, 3, and 4, and from the edge of the through lane *to the toe of the slope, as in Condition 6.*
- The Shoulder in the diagrams provided is understood to be the "Useable Shoulder"
- Slope ratios are expressed, in feet, as 3H:1V, 4H:1V, 5H:1V. The first number represents the horizontal distance and the second represents the vertical distance (see Figure 900-1).




**Slope Ratio**
***Figure 900-1***

- For fill sections where the sideslope area includes multiple slope ratios of 4H:1V or flatter (Condition 5), the applicable slope ratio should be determined based on averaging the slope ratios according to the following method:

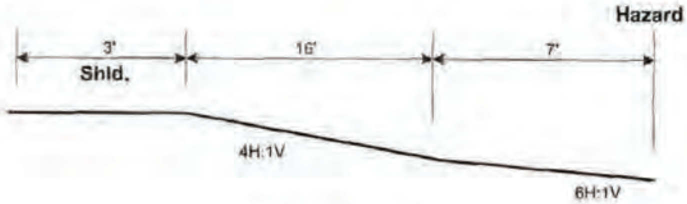
  Slope Averaging

  1. $A1/A2 + B1/B2 = C$
  2. Slope Average $= \frac{A1+B1}{C}$

  Where:

  A1 = width of the first slope section, measured from the beginning of the sideslope to the beginning of the next slope section
  A2 = horizontal value in the slope ratio corresponding with A1
  B1 = width of the next slope section, measured from the beginning of the section to the face of utility object
  B2 = horizontal value in the slope ratio corresponding with B1

**Example:**




**Slope Averaging**
*Figure 900-2*

A1 = 16, A2 = 4, B1 = 7, B2 = 6

1. 16/4 + 7/6 = 4 + 1.17 = 5.17
2. 23/5.17 = 4.45 Average slope = 4:1

- The Recovery Area Formula (see 900.07) is normally used when the cut section foreslope (Condition 4) or the fill section sideslope (Condition 6) is steeper than 4H:1V, but not steeper than 3H:1V. When using the Recovery Area Formula to calculate the Clear Zone, if the highway section includes a ditch, slope data for the backslope must also be collected and factored into the formula.
- When auxiliary lanes for parking, vehicle pull-out, turning, or storage are present, the Control Zone begins at the edge of the through lane. When the Recovery Area Formula is used, the shoulder width distance will include these auxiliary lane widths.
- For managed access city streets that are part of state highways, cities may adopt Control Zone standards that vary from the requirements of this chapter (see RCW 47.24.020).

### (2) *Determining the Control Zone Distance for Various Highway Geometric Conditions*

Control Zone distance at a particular location is determined using the following methods. Choose one of the six Conditions with matching highway section characteristics and follow the listed steps and instructions. The table referred to in this section is the Clear Zone Distance Table (see Figure 900-9).

### (3) *Cut Sections: Conditions 1, 2, 3, and 4*

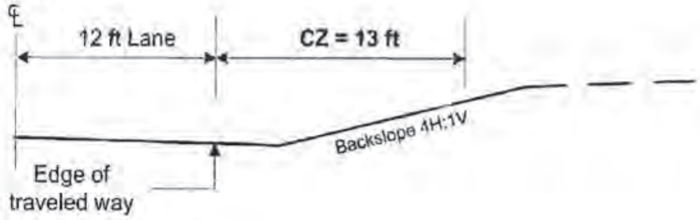
#### (a) Cut Section: Condition 1

- **No ditch**
- **Backslopes of 3H:1V or flatter**

The Control Zone is read directly from the table based on posted speed, average daily traffic (ADT), and backslope.

**Step 1:** Locate posted speed
**Step 2:** Locate ADT
**Step 3:** Locate backslope
**Step 4:** Read CZ directly from table

**Example:**




Step 1: Speed is 45 mph
Step 2: Traffic is 1900 ADT
Step 3: Backslope is 4H:1V
Step 4: Read 13 feet directly from table
Control Zone = 13 feet

**Control Zone Cut Section: Condition 1**
*Figure 900-3*

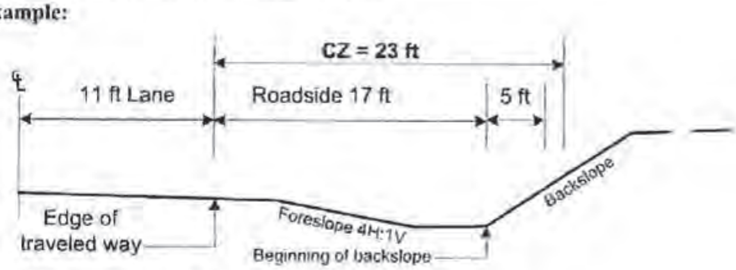
**(b) Cut Section: Condition 2**

- **Ditch foreslopes of 4H:1V or flatter**
- **For all backslopes, use 10H:1V cut section in calculations**

The Control Zone distance is the greater of:

1. Read directly from the table based on posted speed, average daily traffic (ADT), and a backslope of 10H:1V.
   **Step 1:** Locate posted speed
   **Step 2:** Locate ADT
   **Step 3:** Use backslope of 10H:1V
   **Step 4:** Read directly from table
2. Five feet beyond the roadside width.
   **Step 1:** Locate roadside width
   **Step 2:** Add 5 feet to the roadside width

**Example:**




1. Step 1: Speed is 55 mph
   Step 2: Traffic is 4200 ADT
   Step 3: Foreslope 4H:1V or flatter: use a backslope of 10H:1V (from table)
   Step 4: Read 23 feet directly from table
2. Step 1: Roadside width is 17 feet
   Step 2: 17 feet plus 5 feet = 22 feet

Solution = Greater of: 1. = 23 feet or 2. = 22 feet
Control Zone = 23 feet

**Control Zone Cut Section: Condition 2**
*Figure 900-4*

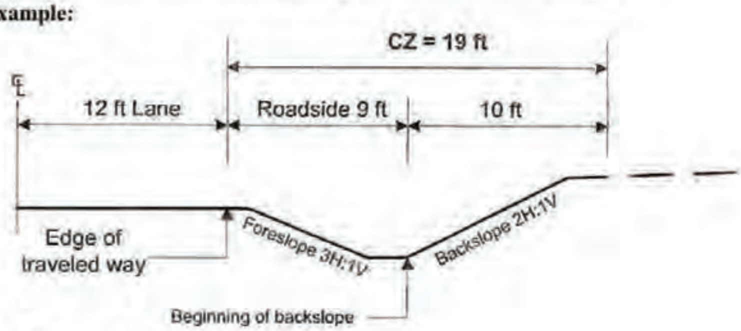
**(c) Cut Section: Condition 3**

- **Ditch foreslope is steeper than 4H:1V**
- **Ditch backslope is steeper than 3H:IV**

The Control Zone distance is established at 10 feet beyond the beginning of backslope (roadside width).

**Step 1:** Locate roadside width
**Step 2:** Add 10 feet to the beginning of backslope (roadside width)

**Example:**




Step 1: Roadside width is 9 feet
Step 2: 9 feet plus 10 feet = 19 feet
**Control Zone = 19 feet**

**Control Zone Cut Section: Condition 3**
*Figure 900-5*

**(d) Cut Section: Condition 4**

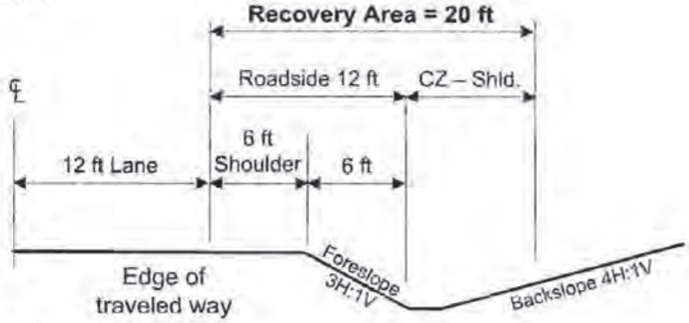
- **Ditch foreslope is steeper than 4H:1V, but not steeper than 3H:1V***
- **Ditch backslope is 3H:1V or flatter**

*Note: For steeper slopes, the Recovery Area Formula may be used as a guide if the difference in elevation between the edge of travelled way and bottom of ditch is 10 feet or less.

The Control Zone distance is the recovery area calculated using the Recovery Area Formula (see 900.07).

**Step 1:** Locate posted speed
**Step 2:** Locate ADT
**Step 3:** Locate backslope
**Step 4:** Read CZ distance from table
**Step 5:** Locate roadside width
**Step 6:** Locate shoulder width
**Step 7:** Use Recovery Area Formula

**Example:**




Step 1: Speed is 40 mph
Step 2: Traffic is 3000 ADT
Step 3: Backslope is 4H:1V
Step 4: Read from table, CZ is 14 feet
Step 5: Roadside width is 12 feet (6-foot shoulder + 6-foot horizontal distance)
Step 6: Shoulder width is 6 feet
Step 7: (12 feet) + (14 feet – 6 feet) = 20 feet
Control Zone = 20 feet

**Control Zone Cut Section: Condition 4**
*Figure 900-6*

### *(4) Fill Section: Conditions 5 and 6*

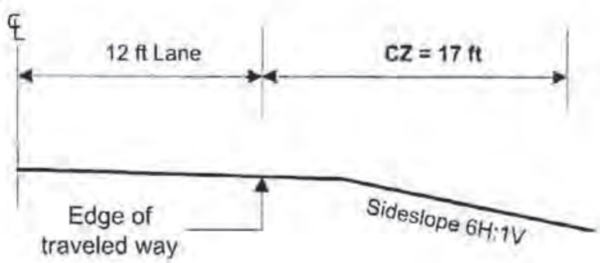
**(a) Fill Section: Condition 5**

- **Sideslope is 4H:1V or flatter**

The Control Zone distance is read directly from the table based on posted speed, sideslope, and average daily traffic (ADT).

**Step 1:** Locate posted speed
**Step 2:** Locate ADT
**Step 3:** Locate sideslope (use slope averaging formula; see [illegible] when sideslope ratio varies)
**Step 4:** Read CZ directly from table

**Example:**




Step 1: Speed is 50 mph
Step 2: Traffic is 320 ADT
Step 3: Sideslope is 6H:1V
Step 4: Read 17 feet directly from table
Control Zone = 17 feet

**Control Zone Fill Section: Condition 5**
*Figure 900-7*

(b) **Fill Section: Condition 6**

- **Sideslope is 3H:1V or steeper***

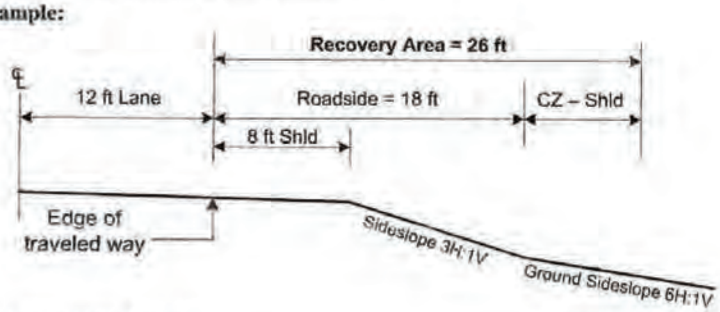
The Control Zone distance is the recovery area, calculated using the Recovery Area Formula (see 900.07).

*Note: Recovery Area Formula normally applies to slopes steeper than 4H:1V, but not steeper than 3H:1V. For steeper slopes, the Recovery Area Formula may be used as a guide if the embankment height is 10 feet or less.

Recovery Area = shoulder width + horizontal nonrecoverable sideslope distance (roadside width) + (Control Zone distance from table – shoulder width)

**Step 1:** Locate posted speed
**Step 2:** Locate ADT
**Step 3:** Locate existing ground sideslope
**Step 4:** Read CZ distance from table
**Step 5:** Locate roadside width
**Step 6:** Locate shoulder width
**Step 7:** Use Recovery Area Formula

**Example:**




Step 1: Speed is 40 mph
Step 2: Traffic is 3000 ADT
Step 3: Existing ground sideslope is 6H:1V
Step 4: Read from table, CZ is 16 feet
Step 5: Roadside width is 18 feet
Step 6: Shoulder width is 8 feet
Step 7: (18 feet) + (16 feet – 8 feet shld) = 26 feet

**Control Zone = 26 feet**

Note: For positive (+) ground sideslopes, use Condition 3 or 4.

**Control Zone Fill Section: Condition 6**
*Figure 900-8*

**Clear Zone Distances for State Highways Outside Incorporated Cities***
(In feet, from edge of traveled way**)

| Posted Speed mph | Average Daily Traffic | Cut Section (Backslope) (H:V) | | | | | | Fill Section (H:V) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3:1 | 4:1 | 5:1 | 6:1 | 8:1 | 10:1 | 3:1 | 4:1 | 5:1 | 6:1 | 8:1 | 10:1 |
| 35 or Less | The Control Zone distance is 10 feet | | | | | | | | | | | | |
| 40 | Under 250 | 10 | 10 | 10 | 10 | 10 | 10 | *** | 13 | 12 | 11 | 11 | 10 |
| | 251-800 | 11 | 11 | 11 | 11 | 11 | 11 | *** | 14 | 14 | 13 | 12 | 11 |
| | 801-2000 | 12 | 12 | 12 | 12 | 12 | 12 | *** | 16 | 15 | 14 | 13 | 12 |
| | 2001-6000 | 14 | 14 | 14 | 14 | 14 | 14 | *** | 17 | 17 | 16 | 15 | 14 |
| | Over 6000 | 15 | 15 | 15 | 15 | 15 | 15 | *** | 19 | 18 | 17 | 16 | 15 |
| 45 | Under 250 | 11 | 11 | 11 | 11 | 11 | 11 | *** | 16 | 14 | 13 | 12 | 11 |
| | 251-800 | 12 | 12 | 13 | 13 | 13 | 13 | *** | 18 | 16 | 14 | 14 | 13 |
| | 801-2000 | 13 | 13 | 14 | 14 | 14 | 14 | *** | 20 | 17 | 16 | 15 | 14 |
| | 2001-6000 | 15 | 15 | 16 | 16 | 16 | 16 | *** | 22 | 19 | 17 | 17 | 16 |
| | Over 6000 | 16 | 16 | 17 | 17 | 17 | 17 | *** | 24 | 21 | 19 | 18 | 17 |
| 50 | Under 250 | 11 | 12 | 13 | 13 | 13 | 13 | *** | 19 | 16 | 15 | 13 | 13 |
| | 251-800 | 13 | 14 | 14 | 15 | 15 | 15 | *** | 22 | 18 | 17 | 15 | 15 |
| | 801-2000 | 14 | 15 | 16 | 17 | 17 | 17 | *** | 24 | 20 | 18 | 17 | 17 |
| | 2001-6000 | 16 | 17 | 17 | 18 | 18 | 18 | *** | 27 | 22 | 20 | 18 | 18 |
| | Over 6000 | 17 | 18 | 19 | 20 | 20 | 20 | *** | 29 | 24 | 22 | 20 | 20 |
| 55 | Under 250 | 12 | 14 | 15 | 16 | 16 | 17 | *** | 25 | 21 | 19 | 17 | 17 |
| | 251-800 | 14 | 16 | 17 | 18 | 18 | 19 | *** | 28 | 23 | 21 | 20 | 19 |
| | 801-2000 | 15 | 17 | 19 | 20 | 20 | 21 | *** | 31 | 26 | 23 | 22 | 21 |
| | 2001-6000 | 17 | 19 | 21 | 22 | 22 | 23 | *** | 34 | 29 | 26 | 24 | 23 |
| | Over 6000 | 18 | 21 | 23 | 24 | 24 | 25 | *** | 37 | 31 | 28 | 26 | 25 |
| 60 | Under 250 | 13 | 16 | 17 | 18 | 19 | 19 | *** | 30 | 25 | 23 | 21 | 20 |
| | 251-800 | 15 | 18 | 20 | 20 | 21 | 22 | *** | 34 | 28 | 26 | 23 | 23 |
| | 801-2000 | 17 | 20 | 22 | 22 | 23 | 24 | *** | 37 | 31 | 28 | 26 | 25 |
| | 2001-6000 | 18 | 22 | 24 | 25 | 26 | 27 | *** | 41 | 34 | 31 | 29 | 28 |
| | Over 6000 | 20 | 24 | 26 | 27 | 28 | 29 | *** | 45 | 37 | 34 | 31 | 30 |
| 65 | Under 250 | 15 | 18 | 19 | 20 | 21 | 21 | *** | 33 | 27 | 25 | 23 | 22 |
| | 251-800 | 17 | 20 | 22 | 22 | 24 | 24 | *** | 38 | 31 | 29 | 26 | 25 |
| | 801-2000 | 19 | 22 | 24 | 25 | 26 | 27 | *** | 41 | 34 | 31 | 29 | 28 |
| | 2001-6000 | 20 | 25 | 27 | 27 | 29 | 30 | *** | 46 | 37 | 35 | 32 | 31 |
| | Over 6000 | 22 | 27 | 29 | 30 | 31 | 32 | *** | 50 | 41 | 38 | 34 | 33 |
| 70 | Under 250 | 16 | 19 | 21 | 21 | 23 | 23 | *** | 36 | 29 | 27 | 25 | 24 |
| | 251-800 | 18 | 22 | 23 | 24 | 26 | 26 | *** | 41 | 33 | 31 | 28 | 27 |
| | 801-2000 | 20 | 24 | 26 | 27 | 28 | 29 | *** | 45 | 37 | 34 | 31 | 30 |
| | 2001-6000 | 22 | 27 | 29 | 29 | 31 | 32 | *** | 50 | 40 | 38 | 34 | 33 |
| | Over 6000 | 24 | 29 | 31 | 32 | 34 | 35 | *** | 54 | 44 | 41 | 37 | 36 |

*This figure also applies to limited access state highways in cities and median areas on managed access state highways in cities. (See the *Design Manual* for guidance on managed access state highways within incorporated cities.)

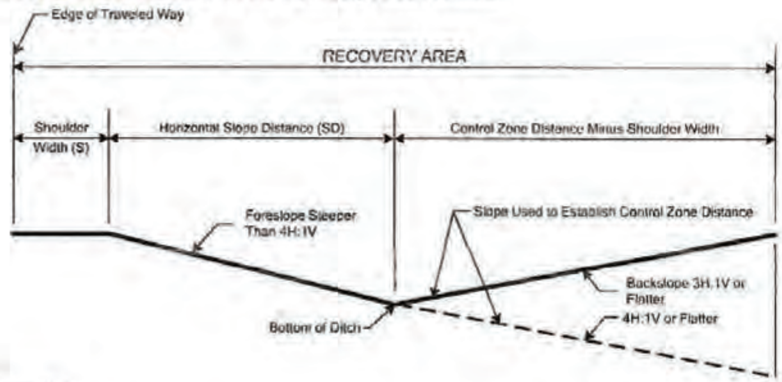
**Traveled way: The portion of the roadway intended for the movement of vehicles, exclusive of shoulders and lanes for parking, turning, and storage for turning.

***When the fill section slope is steeper than 4H:1V, but not steeper than 3H:1V, the Control Zone distance is modified by the Recovery Area Formula and is referred to as the recovery area. The basic philosophy behind the Recovery Area Formula is that a vehicle can traverse these slopes but cannot recover (control steering); therefore, the horizontal distance of these slopes is added to the Control Zone distance to form the recovery area.

**Clear Zone Distance Table**
***Figure 900-9***

## 900.07 Recovery Area

Note: Figure 900-10 clarifies the Recovery Area Formula.




Formula:
Recovery Area =
(shoulder width) + (horizontal distance) + (Control Zone distance – shoulder width)

**Recovery Area**
*Figure 900-10*

**Example**

| Fill Section (Slope 3H:1V or Steeper) | |
|---|---|
| **Conditions** | Speed – 45 mph<br>Traffic – 3000 ADT<br>Slope – 3H:1V |
| **Criteria** | Slope 3H:1V – Use Recovery Area Formula |


| Recovery Area = (shoulder width) + (horizontal distance) + (Control Zone distance – shoulder width) | | | |
|---|---|---|---|
| 29 feet = | 8 + | 12 + | (17 – 8) |

**Recovery Area Calculation**
*Figure 900-11*

## 900.08 Supplemental Utility Design Information

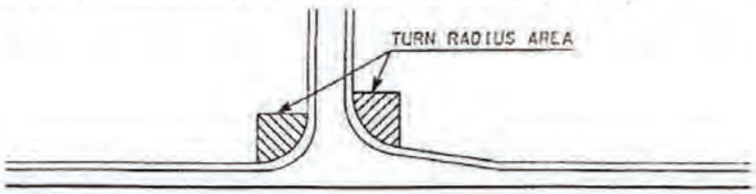
The following items are provided as a guide to the utility industry for consideration during design and maintenance of its facilities.

### *(1) Horizontal Curves*

If it is not necessary, do not place utility objects on the outside of horizontal curves.

### *(2) Public Grade Intersections*

When possible, design the facility placing utility objects outside the turn radius area of public grade intersections (see Figure 900-12). If this is not possible, the facility should, at a minimum, be placed outside the Control Zone in relation to the state highway. If the intersecting road is a local agency roadway with a stop condition at the state highway intersection, the facility must be placed at least 10 feet from the edge of the travelled way for the portion of the local agency roadway leg within WSDOT ownership. If WSDOT ownership of the local agency roadway leg exceeds more than 250 feet back from the stop bar at the highway intersection, contact HQ Utilities for additional guidance. Applicable local agency standards shall apply outside of WSDOT-owned right of way.




**Intersection Radius Area**
*Figure 900-12*

### *(3) Placement of Utility Objects Behind Barriers*

Do not place objects within the deflection distance of any barrier used.

### *(4) Service Poles*

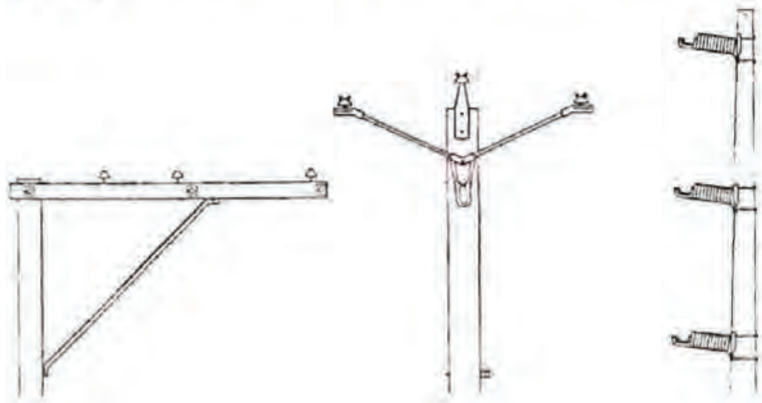
Place service poles on owners' property, not state right of way. Consideration should be given to placing the service pole as far as possible from the highway right of way—at a minimum, outside the Control Zone.

### *(5) Pole Design*

When Control Zone requirements within the highway right of way are tight, consideration should be given to alternative pole designs that may allow construction at or close to the right of way line (see Figure 900-13).

### *(6) Guy Poles/Wires*

Guy poles and/or wires are not to be installed between the pole line and highway lanes unless the guy pole/wire is outside the Control Zone. Guy and anchor wires are considered hazard objects.

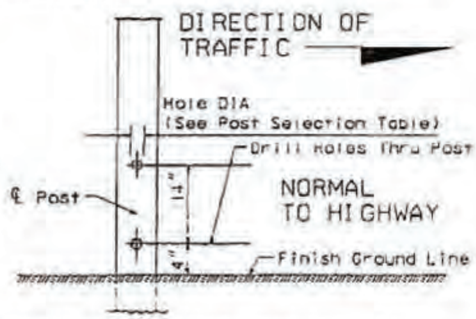


**Alternative Pole Designs**
*Figure 900-13*

### *(7) Utility Location Markers*

Markers used to identify or protect utility facilities, such as a telephone pedestal, may not be larger than a 4 × 4 (16 sq. inches) wood post unless drilled to accommodate breakaway. Solid markers, such as concrete, may not be used. Telephone pedestals that meet the breakaway criteria are acceptable within the Control Zone.

| Post Size | Hole DIA |
|---|---|
| 4 × 4 | — |
| 4 × 6 | 1½ inch |
| 6 × 6 | 2 inch |
| 6 × 8 | 3 inch |




***Note:*** Posts that are larger than 6 × 8 require barrier protection when located within the Control Zone.
(See the *Standard Plans* for further guidance.)

**Wood Post Breakaway Details**
*Figure 900-14*

## 900.09 Project Applications

### (1) New Utility Facility Construction

(a) The utility constructs a new line or extends an existing line within highway right of way.

1. New utility objects will be constructed outside of the Control Zone unless a variance is approved.
2. The utility will submit to WSDOT the following data if applicable:
   - Utility Accommodation Application.
   - Mitigation proposals for existing objects, if applicable, including plans.
   - Submittals supporting variance, if applicable, as specified in 900.11.
   - A completed copy of the Utility Object Relocation Record listing new utility objects.

### (2) Existing Utility Reconstruction

(a) The utility replaces twenty-five percent (25%) or more of the existing poles or towers within any mile. Periodic pole or tower replacement is not included.

1. Utility objects will be relocated outside of the Control Zone unless a variance is approved.
2. The utility will submit to WSDOT the following data if applicable:
   - Utility Accommodation Application.
   - Mitigation proposals for existing objects, including plans.
   - Submittals supporting variance, as specified in 900.11.
   - A copy of the completed Utility Object Relocation Record.

### (3) Utility Relocation Required by WSDOT Improvement Projects

(a) Conditions: WSDOT may address individual safety items.

1. WSDOT will conduct an accident analysis to determine spot safety improvement needs.
2. Any individual Location I or Location II Objects that demonstrate a need for adjustment will be relocated outside of the Control Zone or mitigated (see 900.03) in conjunction with the project.
3. No consideration for variance will be given until all alternative measures have been investigated and determined not feasible.
4. At the time the project preliminary estimate is prepared, WSDOT will notify the utility of the project and request that the utility commit to a course of action.
5. The utility will submit to WSDOT the following data if applicable:
   - Utility Accommodation Application.
   - Mitigation proposals for existing objects, if applicable, including plans.
   - Submittals supporting variance, if applicable (see 900.11).
   - A copy of the completed Utility Object Relocation Record.

(b) Conditions: WSDOT addresses safety items.

1. The utility will adjust all identified Objects to comply with Control Zone requirements.
2. No consideration of variance will be given until all alternative measures have been investigated and determined not feasible.
3. At the time the project preliminary estimate is approved, WSDOT will notify the utility of the project scope and the Location I Object and Location II Object responsibility.
4. When the project Design Summary is completed, WSDOT will request that the utility adjust all Location I Objects and selected Location II Objects.
5. The utility will submit to WSDOT the following data if applicable:
   - Utility Accommodatin Application.
   - Mitigation proposals for existing objects, if applicable, including plans.
   - Submittals supporting variance, if applicable (see 900.11).
   - A copy of the completed Utility Object Relocation Record.

## 900.10 Completing the Utility Object Relocation Record

A completed Utility Object Relocation Record (see Appendix B) form shall accompany any utility submittals to WSDOT as part of a Franchise or Permit Amendment, Franchise Renewal/Consolidation, or highway project-related relocation coordination when objects exist or are proposed to be in Location I or II. Following is the information needed on the form.

### (1) Form Headings

Enter the utility owner and location and other identification information on the top left side of the form.

Enter the milepost limits beside the proper type of construction on the top right side of the form.

### (2) Existing Object Information

Identify the utility object by entering the milepost, pole or object number, location left or right of highway centerline (left or right is determined facing the increasing highway milepost), type of object (i.e., transmission, guy), and whether it is owned, jointly owned, or leased.

### (3) Roadway Data

The speed, average daily traffic (ADT) , and the right of way width from centerline can be obtained from the Region Utilities Office. Also, ADTs can be found in the Annual Traffic Report and highway speed in the State Highway Log. These can be obtained at the Transportation Data and GIS Office website:
www.wsdot.wa.gov/mapsdata/tdgo_home.htm

### (4) Field Measurements

Enter the slope and distance measurements required to calculate the Control Zone distances (see 900.06).

### (5) Control Zone Calculations

From the Control Zone Distance section (see 900.06):

- Enter the Condition number that was used to calculate the Control Zone distance.
- Enter the calculated Control Zone distance.
- Enter whether the object is Location I or Location II.

*Notice that the Location III Objects do not need to be entered on the form.*

### (6) Planned Object Correction

This section is used by the utility to record, on the Utility Object Relocation Record form (see Appendix B), its decision on how the utility object will be corrected.

- For utility objects that will be relocated outside the Control Zone, (see 900.03), mark the relocated distance in the Reloc. Dist column.
- For utility objects that will be corrected with the use of an alternative measure, mark the Alternate Measure column.
- If mitigation is the alternative measure chosen, justification for the use of mitigation and a plan showing proposed mitigation are required for WSDOT review and approval.
- For individual utility Location I Objects that cannot be relocated outside the Control Zone or corrected with the use of an alternative measure, and for which a variance will be requested, mark the LOC I VAR. column.
- To be considered for a variance, the utility must submit to WSDOT a request for a variance together with the required justification (see 120.14).

For individual utility Location II Objects that cannot be relocated outside the Control Zone or corrected with the use of an alternative measure and for which a variance will be requested, mark the "LOC II Variance" column.

## 900.11 Variance

WSDOT recognizes that conditions may arise that make it impracticable to comply with Control Zone requirements. Variances from such compliance may be allowed on a case-by-case basis when clearly justified, as specified in the following sections.

Examples of conditions rendering compliance impracticable include:

- Inadequate right of way to accommodate utility objects outside the Control Zone.
- Physical limitations due to terrain or topography.
- Unjustifiably high costs to relocate or underground the utility facility.

### (1) Utility Object Location Category Reference

#### (a) Location I Utility Objects

Fixed utility objects located within the Control Zone in the following areas:

- The outside of horizontal curves where advisory speeds for the curve are 15 mph or more below the posted speed limit of that section of highway.
- Within the turn radius area of public road grade intersections.

- Where a barrier, embankment, rock outcropping, ditch, or other roadside feature is likely to direct a vehicle into a utility object.
- Closer than 5 feet horizontal beyond the edge of the usable shoulder.

**(b) Location II Utility Objects**

Fixed utility objects located within the Control Zone that are not classified as Location I or Location III Objects.

**(c) Location III Utility Objects**

Fixed utility objects that are:

- Located outside the Control Zone.
- Within the Control Zone and mitigated by an alternate countermeasure consistent with the state's *Utilities Accommodation Policy*.

## 900.12 Variance Request for Location I Objects

Compliance with the WSDOT Control Zone Policy requires adjustment of all Location I Objects outside of the Control Zone. Exceptions may be granted only after an independent analysis and recommendation is completed by a WSDOT review team, including the Region and HQ Utilities Engineers, in consultation with WSDOT subject matter experts as appropriate for the location. Reviews for this purpose will consider relevant highway operational and geometric factors, accident history, and assessment of possible mitigation strategies. Exceptions will be allowed only if it is determined, at the department's discretion, that no reasonable alternative measures are available, with safety being the primary consideration. These requests will be assessed on a case-by-case basis, and will require specific information and documentation from the utility as determined by the review team. Documentation for the review team's investigation and recommendations should be included in the franchise or permit file.

The Utility will be required to complete a Control Zone Variance Request – Justification for Location 1 variances. The Region Utilities Engineer may determine additional information is necessary to consider the Location I variance request. Submittal of a variance request does not mean approval will be given.

## 900.13 Variance Request for Location II Objects

The primary objective for Location II Objects is to relocate them outside of the Control Zone. If achieving this objective is not possible or practicable, the Region Utilities Engineer may authorize variance requests for Location II Objects based on the justification criteria described below.

There are two categories of Location II Objects addressed in this section:

- Location II Objects that have no recorded accident history and are not located within an area of concentrated utility object crashes; and
- Location II Objects that do have recorded accident history, are located within an area of concentrated utility object crashes, or are otherwise determined by WSDOT to be appropriate for additional justification, as specified for this category of objects.

### (1) Location II Objects With No Accident History

The following covers Location II Objects that have no accident history and are not located within an area of concentrated utility object crashes.

The Utility will be required to complete a Control Zone Variance Request – Justification to initiate any requests for Location II variances, or to use the Roadside Safety Analysis Program (RSAP) to support the justification.

For this category of Location II Objects, Control Zone Variance Request Justification may be substituted with an analysis of alternative mitigation strategies using the RSAP, described below, to support selection of the most effective mitigation strategy.

Alternative mitigation strategies include:

1. Placing the utility line underground.
2. Reducing the number of utility objects through joint use, increasing span lengths, and/or placing utility objects on only one side of the road.
3. Increasing the lateral offset of utility objects from the edge of the traveled way to the extent possible.
4. Locating the object within an inaccessible area such as toward the top or on the top of cut slopes.
5. Installing protective devices such as guardrail, berms, traffic barriers, or impact attenuators. (Refer to *Design Manual* Chapter 1600 for Guidelines for Embankment Barrier).
6. Using a breakaway design.
7. Other location-specific measures that may be evident or identified by WSDOT.

RSAP analysis can support justification for a particular alternative; however, it is not necessarily the deciding factor in WSDOT's review. Objects subject to RSAP analysis will be independently reviewed by the Region Utilities Engineer to identify (1) any unique location characteristics that should be more closely considered beyond the minimum required justification, and/or (2) opportunities for mitigation measures not considered in the application.

### (2) Location II Objects With Accident History

The following covers Location II Objects with accident history, that are located within an area of concentrated utility object crashes, or that are determined by WSDOT to be appropriate for additional justification.

A completed Control Zone Variance Request – Justification should be submitted to initiate any requests for Location II variances.

### (3) Roadside Safety Analysis Program

The Roadside Safety Analysis Program (RSAP) is a benefit/cost analysis program developed under NCHRP Project 22-27, and endorsed in the AASHTO *Roadside Design Guide*, as a tool for comparative analysis of alternative site-specific treatments to enhance roadside safety. The intent of the program is to identify the most cost-effective engineering treatments to address roadside safety, and compare the benefits and costs of implementing multiple alternatives.

RSAP analyzes alternatives based on certain factors and location characteristics such as highway operation; installation and maintenance costs; traffic growth; project life; probable collision frequency and severity; and the expected reduction in the future cost of crashes associated with each alternative.

The default values provided by the RSAP system should be used, except for the following factors:

- **Traffic Growth Rate:** Obtain percentage of annual growth from the Region Traffic Office or Transportation Data and GIS Office.
- **Cost of installation, repair, maintenance, salvage value, and life of object:** RSAP provides default values, but actual values should be used if known.

***Note:*** Additional guidance specifying required RSAP submittals will be added to Chapter 9. HQ Utilities is currently coordinating training by the program developer and will establish this additional guidance once training is complete.

The RSAP program and information regarding its use may be accessed at the following website: http://rsap.roadsafellc.com

*Abbreviations and acronyms used without definitions in TRB publications:*

| | |
|---|---|
| A4A | Airlines for America |
| AAAE | American Association of Airport Executives |
| AASHO | American Association of State Highway Officials |
| AASHTO | American Association of State Highway and Transportation Officials |
| ACI–NA | Airports Council International–North America |
| ACRP | Airport Cooperative Research Program |
| ADA | Americans with Disabilities Act |
| APTA | American Public Transportation Association |
| ASCE | American Society of Civil Engineers |
| ASME | American Society of Mechanical Engineers |
| ASTM | American Society for Testing and Materials |
| ATA | American Trucking Associations |
| CTAA | Community Transportation Association of America |
| CTBSSP | Commercial Truck and Bus Safety Synthesis Program |
| DHS | Department of Homeland Security |
| DOE | Department of Energy |
| EPA | Environmental Protection Agency |
| FAA | Federal Aviation Administration |
| FAST | Fixing America's Surface Transportation Act (2015) |
| FHWA | Federal Highway Administration |
| FMCSA | Federal Motor Carrier Safety Administration |
| FRA | Federal Railroad Administration |
| FTA | Federal Transit Administration |
| HMCRP | Hazardous Materials Cooperative Research Program |
| IEEE | Institute of Electrical and Electronics Engineers |
| ISTEA | Intermodal Surface Transportation Efficiency Act of 1991 |
| ITE | Institute of Transportation Engineers |
| MAP-21 | Moving Ahead for Progress in the 21st Century Act (2012) |
| NASA | National Aeronautics and Space Administration |
| NASAO | National Association of State Aviation Officials |
| NCFRP | National Cooperative Freight Research Program |
| NCHRP | National Cooperative Highway Research Program |
| NHTSA | National Highway Traffic Safety Administration |
| NTSB | National Transportation Safety Board |
| PHMSA | Pipeline and Hazardous Materials Safety Administration |
| RITA | Research and Innovative Technology Administration |
| SAE | Society of Automotive Engineers |
| SAFETEA-LU | Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005) |
| TCRP | Transit Cooperative Research Program |
| TDC | Transit Development Corporation |
| TEA-21 | Transportation Equity Act for the 21st Century (1998) |
| TRB | Transportation Research Board |
| TSA | Transportation Security Administration |
| U.S. DOT | United States Department of Transportation |

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