



# **Crashes: Reporting, Studies, and Countermeasures**

## **Did You Know?**

Despite a considerable decline in highway fatalities and serious injuries over the past 4 years, motor vehicle crashes continue to be one of the leading causes of death in the United States. In 2010, more than 5.4 million<sup>1</sup> police-reported crashes occurred on our nation's highways and over 32,000 people died as a result.<sup>2</sup> That's 90 fatalities a day, or about one fatality every 15 minutes! SDDCTEA conducted a traffic crash survey in 2000 of 206 military installations which revealed over 15,000 annual crashes with 11 fatalities and over 1,100 injuries.

Human factors (including impaired or distracted driving, speeding or driving too fast for conditions, and careless or reckless driving) are some of the main contributing factors for crashes. However, the vehicle and roadway can contribute to the severity of injuries and/or property damage costs. Transportation engineers know that a definite correlation exists between crashes or crash severity and substandard roadway design or inadequate control measures. Although a crash may be documented as driver error, fatal and serious injury crashes frequently occur because motorists encounter highway hazards. Increasing awareness of the need for roadway improvements to reduce crashes is very important.

<sup>1</sup> NHTSA NCSA Data Resource Website, *Fatality Analysis Reporting System (FARS) Encyclopedia (Crashes 2010)*

<sup>2</sup> NHTSA Traffic Safety Facts Research Note Bulletin, Feb 2012 DOT HS 811 552, "2010 Motor Vehicle Crashes: Overview"

The three major aspects in reducing crashes, often referred to as the three E's, are:

- ✓ Engineering - traffic engineering and vehicle design,
- ✓ Education - information on the safe and proper use of roads, and
- ✓ Enforcement - enforcing traffic laws.

This bulletin addresses only the traffic engineering side.

## **Crash Reporting**

Unfortunately, many installations currently do not maintain detailed vehicular crash records. Their crash forms are generally used only to quantify and track monetary damage (personal injury and property damage), with no specifics of the crash itself. Also, in most cases, crash data is not provided to the transportation or traffic engineers for safety

At a minimum, the following data should be included in a crash report:

- ✓ Location
- ✓ Date and time
- ✓ Environmental conditions (weather, visibility, or road surface condition)
- ✓ Severity (property damage only, injury, and/or fatality)
- ✓ Types of vehicles
- ✓ Collision paths of vehicles (including vehicle direction before impact)
- ✓ Possible cause

## **In This Issue...**

Did You Know? . . . . .	1
Crash Reporting . . . . .	1
Near Misses Or Complaints . . . . .	2

Crash Studies . . . . .	3
Crash Countermeasures . . . . .	3
Summary . . . . .	15

improvement analyses. These practices could put the installation at a disadvantage because detailed crash records are important for developing methods to increase installation roadway safety.

Why is accurate crash data so important? Sometimes deficiencies that may not be apparent can be identified through crash data. For example, a safety audit conducted during a week of dry weather may not reveal that a certain intersection approach becomes slick when wet, or that a roadway ponds with water because of poor drainage. Detailed crash records can provide insight to these problems.

When special funding is available for correcting crash locations, another benefit of maintaining good crash records is to justify and apply additional funds.

Crash reports, when available, should be collected and summarized in an orderly fashion. They are usually filed in the installation security or safety offices.

Crash Report Form	
Date and Time:	5/18/08, 1032
Roadway Number or Name:	Base parking lot
Collision Type:	Rear end
Intersection Type:	N/A
Urban or Rural:	Urban
Number and Types of Vehicles Involved:	1 POV
Number of People Involved:	2
Severity of Accident:	Minor
Number of Fatalities:	0
Number of Injuries:	0
Illumination within the Accident Area:	Some daylight, parking lot lights
Weather Conditions:	Raining
Road Surface Conditions:	Wet
Short Description of the Accident:	While backing westbound out of parking spot, car struck pole.
Possible Cause	Driver inattentiveness

## Near Misses Or Complaints

A history of crashes at certain locations can warrant traffic signals or justify roadway improvements. However, what if there are no recent crashes, nor a documented history of crashes, but instead there are a lot of near misses and complaints about a problem location?

Complaints can be a good way to highlight the problem areas perceived by motorists, which may otherwise be overlooked. However, they should not be viewed as a substitute for a professional evaluation.

When a high number of near misses occur at a particular location, a crash is very likely to occur and possibly inevitable. This relationship between near-miss incidents and major injuries accidents has been studied for decades through organizational and technological systems. Major accidents can be avoided by understanding near misses and eliminating the root cause. So even without a documented history of crashes, there could be justification for recommending improvements based on a significant number of near misses and complaints.

Near-miss incidents can be difficult to quantify since installation law enforcement or safety officials are not typically required to write a report as they are for actual crashes. The American Association of State Highway and Transportation Officials (AASHTO) *Highway Safety Manual* (HSM) helps to predict potential crash reduction, frequency, and severity for various improvements and should be referenced to conduct quantitative safety analyses.

## What's Wrong with These Photos?

Answers on page 15



## Crash Studies

Vehicular crashes should be studied in an attempt to reduce the installation crash rate. SDDCTEA can provide Crash Location Enhancement Studies (CrashLES) often at no cost to the installations. These studies generally involve one or more high crash location and a safety audit. A high crash location is defined as any location with five or more property-damage-only crashes, three or more injury crashes, or one or more fatal crashes in a 12-month period.

Safety audits are a procedural approach to evaluating roadway safety for specific corridors. They focus on pedestrian accommodations, traffic signals, signing and pavement markings, drainage, and roadside hazards.

A Fatal Crash Analysis is similar to a CrashLES study, however it focuses on a specific fatality at a specific location. These studies are generally considered confidential and would not be distributed without permission from the installation.

The basic procedures in a crash study are collection of crash data, identification of high-crash locations, data analysis, and identification of improvements or crash countermeasures.

### Data Collection

Information gained from crash reports may be used to identify necessary improvements that would, in turn, prevent future crashes. Traffic volume information is critical to developing traffic-related improvements, as are field assessments to fully analyze problem areas. Depending on the nature of the crashes, other data may be critical to the crash study as well.

### Identification of High-Crash Locations

Crash reports can be summarized in crash/collision diagrams which are graphical representations of the crash patterns at a particular location. These crash diagrams can quickly illustrate high-crash locations.

### Data Analysis

Once high-crash locations are identified, the data is analyzed to determine the causal or contributory factors. These factors must be explored sufficiently to ensure that design features and control applications are fully evaluated for their contributory role. To evaluate problem locations:

- ✓ Assemble crash reports for the location under study. Typically, the most current 2- to 3-year period is used; however, a 1-year period is acceptable if that is the only data available.

- ✓ Prepare a crash diagram showing direction of approach, type, severity, date, time, and weather conditions at the time of the crash.
- ✓ Prepare a condition diagram, which is a scale drawing of the location showing all physical conditions that may influence driver behavior. The drawing should show all features such as curbs, driveways, markings, traffic control devices, and so forth.
- ✓ Assemble necessary data such as traffic volumes, approach speeds, intersection delay, parking conditions, field assessments, and traffic control device observance.
- ✓ Analyze the problem to define primary and secondary causal contributors.

Once contributory factors are identified, a safety audit can be performed for the intersection or roadway corridor and appropriate countermeasures can be determined.

## Crash Countermeasures

There are numerous reasons for vehicular crashes such as inclement weather, driver distraction or error, road debris or animal obstruction, or substandard roadway geometrics or inadequate traffic control devices. Crashes fall into multiple categories including: rear impact, side impact / sideswipe / angle, head-on collision, rollover, and single car incident / runoff. All types of crashes can be reduced by law enforcement, driver education, and safety-oriented traffic engineering.

### Traffic Engineering Countermeasures

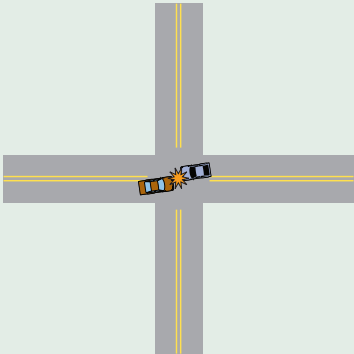
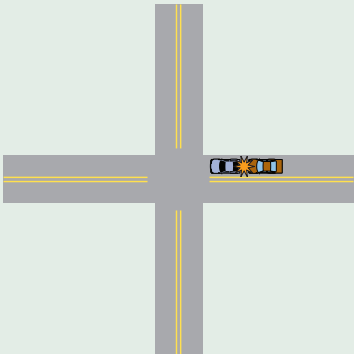
Exhibit 1 shows various crash patterns, their probable causes, and some general traffic engineering countermeasures to eliminate the causes associated with substandard roadway design or inadequate traffic control.

### FHWA Countermeasures

Federal Highway Administration (FHWA) supports and encourages nine effective safety countermeasures be considered when addressing crashes that involve intersections, pedestrians, and roadway departure. These countermeasures are based on the latest safety research and are summarized in Exhibit 2.

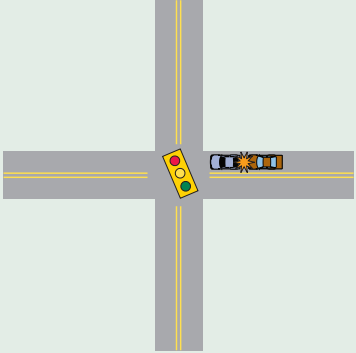
Installation transportation planners and engineers should refer to resources such as the Crash Modification Factors Clearinghouse (<http://www.cmfclearinghouse.org/>) and the FHWA web site (<http://safety.fhwa.dot.gov/provencountermeasures>), for detailed descriptions, related research studies, and evaluations of each of these countermeasures.

### Exhibit 1: General Crash Patterns

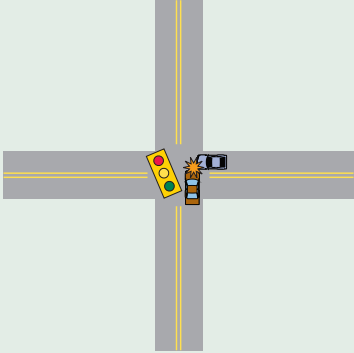
Crash Pattern	Possible Cause	General Countermeasure
<p>Left-turn head-on collisions</p> 	Large volume of left turns	<ul style="list-style-type: none"> <li>✓ Create one-way street</li> <li>✓ Widen road</li> <li>✓ Provide left-turn signal phases</li> <li>✓ Prohibit left turns</li> <li>✓ Reroute left-turn traffic</li> <li>✓ Channelize intersection</li> <li>✓ Install STOP signs (see <i>Manual on Uniform Traffic Control Devices [MUTCD]</i>)</li> <li>✓ Revise signal sequence</li> <li>✓ Provide turning guide lines (if there is a dual left-turn lane)</li> <li>✓ Provide traffic signal if warranted by <i>MUTCD</i></li> <li>✓ Retime signals</li> <li>✓ Add a roundabout</li> </ul>
	Restricted sight distance	<ul style="list-style-type: none"> <li>✓ Remove obstacles</li> <li>✓ Provide adequate channelization</li> <li>✓ Provide special phase for left-turning traffic</li> <li>✓ Provide left-turn lanes</li> <li>✓ Install warning signs</li> <li>✓ Reduce speed limit on approaches</li> </ul>
	Too short yellow phase	<ul style="list-style-type: none"> <li>✓ Increase yellow intervals</li> <li>✓ Provide all-red phase</li> </ul>
	Absence of special left-turning phase	<ul style="list-style-type: none"> <li>✓ Provide special phase for left-turning traffic</li> </ul>
	Excessive speed on approaches	<ul style="list-style-type: none"> <li>✓ Reduce speed limit on approaches</li> </ul>
<p>Rear-end collisions at unsignalized intersections</p> 	Driver not aware of intersection	<ul style="list-style-type: none"> <li>✓ Install/improve warning signs</li> </ul>
	Slippery surface	<ul style="list-style-type: none"> <li>✓ Overlay pavement</li> <li>✓ Provide adequate drainage</li> <li>✓ Groove pavement</li> <li>✓ Reduce speed limit on approaches</li> <li>✓ Provide Slippery When Wet signs</li> </ul>
	Large volume of turning vehicles	<ul style="list-style-type: none"> <li>✓ Create left- and right-turn lanes</li> <li>✓ Prohibit turns</li> <li>✓ Increase curb radii</li> </ul>
	Inadequate roadway lighting	<ul style="list-style-type: none"> <li>✓ Improve roadway lighting</li> </ul>
	Excessive speed on approaches	<ul style="list-style-type: none"> <li>✓ Reduce speed limit on approaches</li> </ul>
	Inadequate gaps	<ul style="list-style-type: none"> <li>✓ Provide traffic signal, if warranted by <i>MUTCD</i></li> <li>✓ Provide STOP signs</li> <li>✓ Add a roundabout</li> </ul>
	Crossing pedestrians	<ul style="list-style-type: none"> <li>✓ Install/improve signing or marking of pedestrian crosswalks</li> </ul>



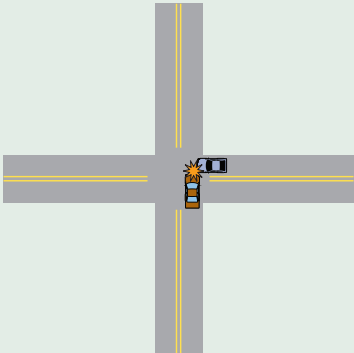
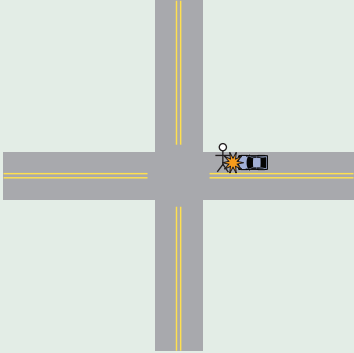
### Exhibit 1: General Crash Patterns (continued)

Crash Pattern	Possible Cause	General Countermeasure
<p>Rear-end collisions at signalized intersections</p> 	Slippery surface	<ul style="list-style-type: none"> <li>✓ Overlay pavement</li> <li>✓ Provide adequate drainage</li> <li>✓ Groove pavement</li> <li>✓ Reduce speed limit on approaches</li> <li>✓ Provide Slippery When Wet signs</li> </ul>
	Large volume of turning vehicles	<ul style="list-style-type: none"> <li>✓ Create left- and right-turn lanes</li> <li>✓ Prohibit turns</li> <li>✓ Increase curb radii</li> <li>✓ Provide special phase for left-turning traffic</li> <li>✓ Add a roundabout</li> </ul>
	Poor visibility of signals	<ul style="list-style-type: none"> <li>✓ Install/improve advance warning devices</li> <li>✓ Install overhead signals</li> <li>✓ Install 12-inch signal lenses</li> <li>✓ Install visors</li> <li>✓ Install backplates</li> <li>✓ Relocate signals</li> <li>✓ Add additional signal heads</li> <li>✓ Remove obstacles</li> <li>✓ Reduce speed limit on approaches</li> </ul>
	Inadequate signal timing	<ul style="list-style-type: none"> <li>✓ Adjust yellow interval</li> <li>✓ Provide progression through a set of signalized intersections</li> <li>✓ Add all-red clearance interval</li> </ul>
	Unwarranted signals	<ul style="list-style-type: none"> <li>✓ Remove signals (see <i>MUTCD</i>)</li> </ul>
	Inadequate roadway lighting	<ul style="list-style-type: none"> <li>✓ Improve roadway lighting</li> </ul>
	Crossing pedestrians	<ul style="list-style-type: none"> <li>✓ Install/improve signing or marking of pedestrian crosswalks</li> <li>✓ Provide pedestrian WALK phase</li> </ul>


### Exhibit 1: General Crash Patterns (continued)

Crash Pattern	Possible Cause	General Countermeasure
<p>Right-angle collisions at signalized intersections</p> 	Restricted sight distance	<ul style="list-style-type: none"> <li>✓ Remove sight obstructions</li> <li>✓ Restrict parking near corners</li> <li>✓ Install warning signs (see <i>MUTCD</i>)</li> <li>✓ Reduce speed limit on approaches</li> <li>✓ Channelize intersections</li> <li>✓ Install advance markings to supplement signs</li> </ul>
	Excessive speed on approaches	<ul style="list-style-type: none"> <li>✓ Reduce speed limit on approaches</li> <li>✓ Increase yellow interval</li> <li>✓ Install rumble strips</li> <li>✓ Add a roundabout</li> </ul>
	Poor visibility of signal	<ul style="list-style-type: none"> <li>✓ Install advance-warning devices</li> <li>✓ Install 12-inch signal lenses</li> <li>✓ Install overhead signal</li> <li>✓ Install visors</li> <li>✓ Install backplates</li> <li>✓ Improve location of signal heads</li> <li>✓ Add additional signal heads</li> <li>✓ Add illuminated street name signs</li> </ul>
	Inadequate signal timing	<ul style="list-style-type: none"> <li>✓ Adjust yellow interval</li> <li>✓ Provide all-red clearance interval</li> <li>✓ Install actuated signal controller</li> <li>✓ Retime signals</li> <li>✓ Provide progression through a set of signalized intersections</li> </ul>
	Inadequate roadway lighting	<ul style="list-style-type: none"> <li>✓ Improve roadway illumination</li> </ul>
	Inadequate intersection advance warning signs	<ul style="list-style-type: none"> <li>✓ Install additional intersection advance warning signs</li> </ul>
	Large intersection volume	<ul style="list-style-type: none"> <li>✓ Retime signals</li> <li>✓ Add traffic lane</li> </ul>

### Exhibit 1: General Crash Patterns (continued)



Crash Pattern	Possible Cause	General Countermeasure
<p>Right-angle collisions at unsignalized intersections</p> 	Restricted sight distance	<ul style="list-style-type: none"> <li>✓ Remove sight obstructions</li> <li>✓ Restrict parking near corners</li> <li>✓ Install STOP signs (see <i>MUTCD</i>)</li> <li>✓ Install warning signs (see <i>MUTCD</i>)</li> <li>✓ Reduce speed limit on approaches</li> <li>✓ Install signal (see <i>MUTCD</i>)</li> <li>✓ Install YIELD signs (see <i>MUTCD</i>)</li> <li>✓ Channelize intersection</li> <li>✓ Install advance markings to supplement signs</li> <li>✓ Install limit lines</li> <li>✓ Add a roundabout</li> </ul>
	Large intersection volume	<ul style="list-style-type: none"> <li>✓ Install signal (see <i>MUTCD</i>)</li> <li>✓ Reroute through traffic</li> </ul>
	Excessive speed on approaches	<ul style="list-style-type: none"> <li>✓ Reduce speed limit on approaches</li> <li>✓ Increase yellow interval</li> <li>✓ Install rumble strips</li> </ul>
	Inadequate roadway lighting	<ul style="list-style-type: none"> <li>✓ Improve roadway illumination</li> </ul>
	Inadequate intersection advance warning signs	<ul style="list-style-type: none"> <li>✓ Install intersection advance warning signs</li> </ul>
	Inadequate traffic control devices	<ul style="list-style-type: none"> <li>✓ Upgrade traffic control devices</li> <li>✓ Increase enforcement</li> </ul>
<p>Pedestrian-vehicular collisions</p> 	Restricted sight distance	<ul style="list-style-type: none"> <li>✓ Remove sign obstructions</li> <li>✓ Install pedestrian crossings</li> <li>✓ Install/improve pedestrian crossing signs</li> <li>✓ Reroute pedestrian paths</li> <li>✓ Prohibit curb parking near crosswalks</li> </ul>
	Inadequate protection for pedestrians	<ul style="list-style-type: none"> <li>✓ Add pedestrian refuge islands</li> <li>✓ Install pedestrian barriers</li> </ul>
	School crossings	<ul style="list-style-type: none"> <li>✓ Use guards at school crossings</li> </ul>
	Inadequate signals	<ul style="list-style-type: none"> <li>✓ Install pedestrian signals (see <i>MUTCD</i>)</li> </ul>
	Inadequate phasing for signal	<ul style="list-style-type: none"> <li>✓ Change timing of pedestrian phase</li> </ul>
	Driver inadequately warned of frequent mid-block crossings	<ul style="list-style-type: none"> <li>✓ Prohibit parking</li> <li>✓ Install warning signs</li> <li>✓ Lower speed limit</li> <li>✓ Install pedestrian barriers</li> </ul>

### Exhibit 1: General Crash Patterns (continued)


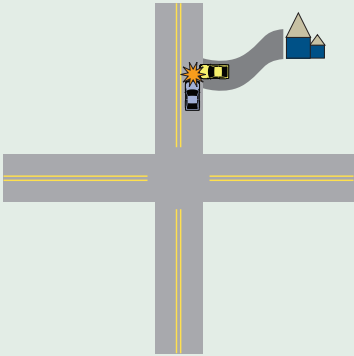
Crash Pattern	Possible Cause	General Countermeasure
Pedestrian-vehicular collisions (continued)	Inadequate pavement markings	<ul style="list-style-type: none"> <li>✓ Install thermoplastic markings</li> <li>✓ Supplement markings with appropriate signing (see <i>MUTCD</i>)</li> <li>✓ Upgrade pavement markings (see <i>MUTCD</i>)</li> </ul>
	Inadequate gaps at unsignalized intersections	<ul style="list-style-type: none"> <li>✓ Install traffic signal, if warranted (see <i>MUTCD</i>)</li> <li>✓ Install pedestrian crosswalk and signs</li> <li>✓ Install pedestrian WALK-DONT WALK signals</li> </ul>
	Inadequate roadway lighting	<ul style="list-style-type: none"> <li>✓ Improve road lighting</li> </ul>
	Excessive vehicle speed	<ul style="list-style-type: none"> <li>✓ Reduce speed limit</li> <li>✓ Install proper warning signs</li> <li>✓ Install pedestrian barriers</li> <li>✓ Use enforcement</li> </ul>
Run off roadway collisions 	Slippery pavement	<ul style="list-style-type: none"> <li>✓ Overlay existing pavement</li> <li>✓ Provide adequate drainage</li> <li>✓ Groove existing pavement</li> <li>✓ Reduce speed limit</li> <li>✓ Provide Slippery When Wet signs</li> </ul>
	Roadway design inadequate for traffic conditions	<ul style="list-style-type: none"> <li>✓ Widen lanes</li> <li>✓ Relocate islands</li> <li>✓ Close curb lanes</li> <li>✓ Install guardrails</li> </ul>
	Poor delineation	<ul style="list-style-type: none"> <li>✓ Improve/install pavement markings</li> <li>✓ Install roadside delineations</li> <li>✓ Install advance warning signs</li> </ul>
	Inadequate roadway lighting	<ul style="list-style-type: none"> <li>✓ Improve roadway lighting</li> </ul>
	Inadequate shoulders	<ul style="list-style-type: none"> <li>✓ Upgrade roadway shoulders</li> </ul>
	Improper channelization	<ul style="list-style-type: none"> <li>✓ Improve channelization</li> </ul>
	Inadequate pavement maintenance	<ul style="list-style-type: none"> <li>✓ Perform road surface repair</li> </ul>
	Poor visibility	<ul style="list-style-type: none"> <li>✓ Increase size of signs</li> </ul>
	Excessive speed on approaches	<ul style="list-style-type: none"> <li>✓ Reduce speed limit</li> </ul>



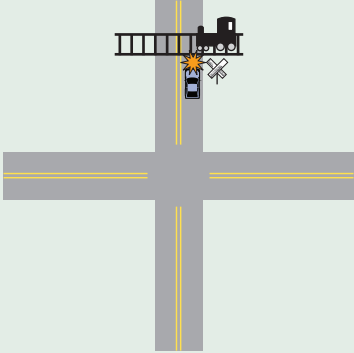
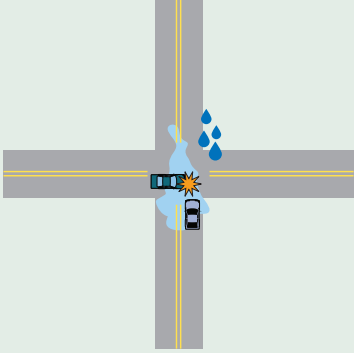
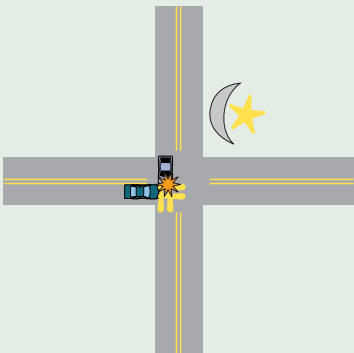
### Exhibit 1: General Crash Patterns (continued)

Crash Pattern	Possible Cause	General Countermeasure
<p>Fixed object collisions</p> 	Obstructions in or too close to roadway	<ul style="list-style-type: none"> <li>✓ Remove obstacles</li> <li>✓ Install barrier curbing</li> <li>✓ Install breakaway features to light poles, signposts, and so forth</li> <li>✓ Protect objects with guardrail</li> <li>✓ Install crash cushioning devices</li> </ul>
	Inadequate roadway lighting	✓ Improve roadway lighting
	Inadequate pavement marking	✓ Install reflectorized pavement lines
	Inadequate signs, delineators, and guardrails	✓ Install reflectorized paint and/or reflectors on the obstruction
	Inadequate road design	<ul style="list-style-type: none"> <li>✓ Provide proper superelevation</li> <li>✓ Improve superelevation at curve</li> <li>✓ Install appropriate warning signs and delineators</li> </ul>
	Slippery surface	<ul style="list-style-type: none"> <li>✓ Improve skid resistance</li> <li>✓ Provide adequate drainage</li> <li>✓ Provide Slippery When Wet signs</li> <li>✓ Groove existing pavement</li> </ul>
	Excessive vehicle speed	<ul style="list-style-type: none"> <li>✓ Reduce speed limit</li> <li>✓ Use enforcement</li> </ul>
<p>Collisions with parked or parking vehicles</p> 	Improper pavement markings	✓ Stripe per recommended standards
	Improper parking clearance at driveways	✓ Post parking restrictions near driveways
	Angle parking	✓ Convert angle parking to parallel parking
	Excessive vehicle speed	✓ Reduce speed limit if justified by spot speed studies
	Illegal parking	✓ Use enforcement
	Improper parking	<ul style="list-style-type: none"> <li>✓ Prohibit parking</li> <li>✓ Create off-street parking</li> </ul>
	Large parking turnover	<ul style="list-style-type: none"> <li>✓ Create one-way streets</li> <li>✓ Reroute through traffic</li> </ul>


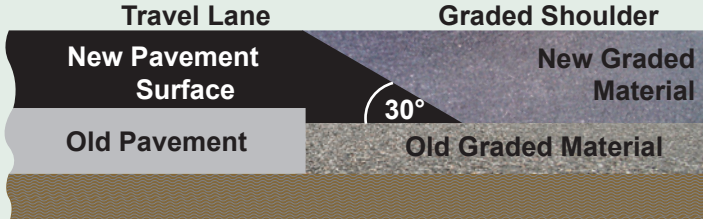


### Exhibit 1: General Crash Patterns (continued)

Crash Pattern	Possible Cause	General Countermeasure
<p>Sideswipe or head-on collisions</p> 	Inadequate roadway design	✓ Create one-way streets and provide wider lanes
	Improper road maintenance	✓ Perform necessary road surface repairs
	Inadequate shoulders	✓ Improve shoulders
	Excessive vehicle speed	✓ Reduce speed limit ✓ Install median devices ✓ Remove constriction such as parked vehicles
	Inadequate pavement markings	✓ Install or refurnish center lines, lane lines, and pavement edge lines ✓ Install reflectorized lines and edges
	Inadequate channelization	✓ Install acceleration and deceleration lanes ✓ Channelize intersection ✓ Provide turning lanes
	Inadequate signing	✓ Add illuminated street name signs ✓ Add advance street name signs ✓ Install lane use control signs at the beginning of turn lanes
<p>Driveway-related collisions</p> 	Left-turning vehicles	✓ Install median devices ✓ Install two-way left-turn lanes
	Improperly located driveway	✓ Regulate minimum spacing of driveways ✓ Move driveway to side street ✓ Install curbing to define driveway location ✓ Consolidate adjacent driveways
	Right-turning vehicles	✓ Provide right-turn lanes ✓ Restrict parking near driveways ✓ Widen driveways ✓ Widen through lanes ✓ Increase curb radii
	Large volume of through traffic	✓ Move driveway to side street ✓ Construct a local service road ✓ Reroute through traffic
	Restricted sight distance	✓ Remove sight obstructions ✓ Restrict parking near driveway ✓ Install/improve street lighting ✓ Reduce speed limit
	Inadequate roadway lighting	✓ Improve roadway lighting




### Exhibit 1: General Crash Patterns (continued)

Crash Pattern	Possible Cause	General Countermeasure
<p>Train-vehicle crashes</p> 	Restricted sight distance	<ul style="list-style-type: none"> <li>✓ Remove sight obstructions</li> <li>✓ Reduce grade</li> <li>✓ Install train-actuated signals (see <i>MUTCD</i>)</li> <li>✓ Install STOP sign (see <i>MUTCD</i>)</li> <li>✓ Install advance warning signs (see <i>MUTCD</i>)</li> <li>✓ Install automated flashers and gates</li> </ul>
	Poor visibility	<ul style="list-style-type: none"> <li>✓ Improve roadway lighting</li> <li>✓ Increase size of signs</li> </ul>
	Improper traffic signal preemption timing	<ul style="list-style-type: none"> <li>✓ Retime traffic signals</li> </ul>
	Excessive vehicle speeds on approaches	<ul style="list-style-type: none"> <li>✓ Revise speed limit</li> </ul>
	Inadequate pavement markings	<ul style="list-style-type: none"> <li>✓ Install advance markings to supplement signs</li> <li>✓ Install limit lines</li> <li>✓ Install/improve pavement markings</li> </ul>
	Slippery surface	<ul style="list-style-type: none"> <li>✓ Skidproof roadway</li> </ul>
	Improper preemption of railroad signals or gates	<ul style="list-style-type: none"> <li>✓ Retime railroad signals and gates</li> </ul>
	Rough crossing surfaces	<ul style="list-style-type: none"> <li>✓ Improve crossing surfaces</li> </ul>
<p>Wet-pavement crashes</p> 	Slippery pavement	<ul style="list-style-type: none"> <li>✓ Overlay existing pavement</li> <li>✓ Groove existing pavement</li> <li>✓ Reduce speed limit</li> <li>✓ Provide Slippery When Wet signs</li> <li>✓ Skidproof roadway</li> </ul>
	Inadequate drainage	<ul style="list-style-type: none"> <li>✓ Provide adequate drainage</li> </ul>
	Inadequate pavement markings	<ul style="list-style-type: none"> <li>✓ Upgrade pavement markings</li> </ul>
<p>Night crashes</p> 	Poor visibility or lighting	<ul style="list-style-type: none"> <li>✓ Install/improve street lighting</li> <li>✓ Install/improve delineation markings</li> <li>✓ Install/improve warning signs</li> </ul>
	Poor sign quality	<ul style="list-style-type: none"> <li>✓ Upgrade signing</li> <li>✓ Provide illuminated signs</li> </ul>
	Inadequate channelization or delineation	<ul style="list-style-type: none"> <li>✓ Install pavement markings</li> <li>✓ Improve delineation markings</li> <li>✓ Provide raised markers</li> <li>✓ Upgrade advance warning signs</li> </ul>

## Exhibit 2: FHWA Recommended Crash Countermeasures




Crash Countermeasure	FHWA's Description	Key Resources (See FHWA's Web Site For More Helpful Resources)
<p><b>Safety Edge</b></p>  <p><b>Pavement Cross Section</b></p> 	<p>An asphalt or concrete paving technique where the edge of the roadway is paved about 30 degrees from the pavement cross slope to prevent loss of vehicle control by the vehicle drifting off of the pavement.</p>	<ul style="list-style-type: none"> <li>✓ The Safety Edge: A Pavement Edge Drop-Off Treatment, FHWA-SA-10-034 <a href="http://www.fhwa.dot.gov/everydaycounts/technology/safetyedge/brochure/brochure.pdf">http://www.fhwa.dot.gov/everydaycounts/technology/safetyedge/brochure/brochure.pdf</a></li> <li>✓ FHWA Guide Specification for the Safety Edge <a href="http://www.fhwa.dot.gov/everydaycounts/technology/safetyedge/specs.cfm">http://www.fhwa.dot.gov/everydaycounts/technology/safetyedge/specs.cfm</a></li> </ul>
<p><b>Roundabouts</b></p> 	<p>This is a type of circular intersection based on three basic operational principles:</p> <ul style="list-style-type: none"> <li>✓ Geometry that results in a low-speed environment</li> <li>✓ Entering traffic yields to vehicles on the circulatory roadway</li> <li>✓ Channelization at the entrance and deflection around a center island.</li> </ul>	<ul style="list-style-type: none"> <li>✓ Roundabouts: An Informational Guide, Second Edition (NCHRP Report 672) <a href="http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_672.pdf">http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_672.pdf</a></li> <li>✓ Roundabouts Outreach &amp; Education Toolbox <a href="http://safety.fhwa.dot.gov/intersection/roundabouts/roundabouttoolbox/">http://safety.fhwa.dot.gov/intersection/roundabouts/roundabouttoolbox/</a></li> <li>✓ Highway Safety Manual, American Association of State Highway and Transportation Officials <a href="http://www.highwaysafetymanual.org/Pages/default.aspx">http://www.highwaysafetymanual.org/Pages/default.aspx</a></li> </ul>
<p><b>Corridor Access Management</b></p> 	<p>Access management is a set of techniques to control access to highways, major arterials, and other roadways. Benefits include improved movement of traffic, reduced crashes, and fewer vehicle conflicts. Principles are applicable to all roadways ranging from freeways to local streets. Successful access management enhances safety, preserves capacity, and provides for pedestrian and bicycle needs.</p>	<ul style="list-style-type: none"> <li>✓ Access Management in the Vicinity of Intersections Technical Summary <a href="http://safety.fhwa.dot.gov/intersection/resources/fhwasa10002/">http://safety.fhwa.dot.gov/intersection/resources/fhwasa10002/</a></li> <li>✓ Access Management Principles <a href="http://ops.fhwa.dot.gov/access_mgmt/presentations/am_principles_intro/index.htm">http://ops.fhwa.dot.gov/access_mgmt/presentations/am_principles_intro/index.htm</a></li> <li>✓ "Safe Access is Good for Business" Brochure <a href="http://ops.fhwa.dot.gov/publications/amprimer/access_mgmt_primer.htm">http://ops.fhwa.dot.gov/publications/amprimer/access_mgmt_primer.htm</a></li> </ul>

## Exhibit 2: FHWA Recommended Crash Countermeasures (continued)

Crash Countermeasure	FHWA's Description	Key Resources (See FHWA's Web Site For More Helpful Resources)
<p><b>Backplates with Retroreflective Borders</b></p> 	<p>Backplates are added to a traffic signal to improve the visibility of the illuminated signal face providing a controlled-contrast background. The backplate is framed with a retroreflective border making the signal head more visible and conspicuous in both day and nighttime conditions. This reduces unintentional red-light running crashes.</p>	<ul style="list-style-type: none"> <li>✓ Retroreflective Borders on Traffic Signal Backplates - A South Carolina Success Story  <a href="http://safety.fhwa.dot.gov/intersection/resources/casestudies/fhwasa09011/">http://safety.fhwa.dot.gov/intersection/resources/casestudies/fhwasa09011/</a> </li> <li>✓ Manual on Uniform Traffic Control Devices (2009 Edition), Part 4D Traffic Control Signal Features  <a href="http://mutcd.fhwa.dot.gov/htm/2009/part4/part4d.htm#section4D12">http://mutcd.fhwa.dot.gov/htm/2009/part4/part4d.htm#section4D12</a> </li> <li>✓ Evaluating Impact on Safety of Improved Signal Visibility at Urban Signalized Intersections  <a href="http://pubsindex.trb.org/view.aspx?id=800943">http://pubsindex.trb.org/view.aspx?id=800943</a> </li> </ul>
<p><b>Longitudinal Rumble Strips and Stripes on Two-Lane Roads</b></p> 	<p>Raised or grooved patterns on the pavement that produce an audible and physical vibration to alert drivers that have veered off the travel lane.</p>	<ul style="list-style-type: none"> <li>✓ NCHRP Report 641, Guidance for the Design and Application of Shoulder and Centerline Rumble Strips, 2009  <a href="http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_641.pdf">http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_641.pdf</a> </li> <li>✓ FHWA Guidance: Revisions to T 5040.39 Shoulder and Edge Line Rumble Strips and T 5040.40 Center Line Rumble Strips  <a href="http://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips/t5040_memo/">http://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips/t5040_memo/</a> </li> </ul>
<p><b>Enhanced Delineation and Friction for Horizontal Curves</b></p> 	<p>Additional enhancements to the <i>MUTCD</i>-recommended curve treatments include: post-mounted delineation in the curve, enhanced signing treatment such as larger chevron signs with enhanced retroreflectivity or dual indicated advanced signs with constant flashing beacons, pavement markings, traditional pavement friction courses, or high-friction surface treatments.</p>	<ul style="list-style-type: none"> <li>✓ Manual on Uniform Traffic Control Devices, FHWA, 2009  <a href="http://mutcd.fhwa.dot.gov/">http://mutcd.fhwa.dot.gov/</a> </li> <li>✓ Low-Cost Treatments for Horizontal Curve Safety, 2006, FHWA-SA-07-002  <a href="http://safety.fhwa.dot.gov/roadway_dept/horcurves/fhwasa07002/">http://safety.fhwa.dot.gov/roadway_dept/horcurves/fhwasa07002/</a> </li> <li>✓ Safety Evaluation of Improved Curve Delineation  <a href="http://www.fhwa.dot.gov/publications/research/safety/09045/09045.pdf">http://www.fhwa.dot.gov/publications/research/safety/09045/09045.pdf</a> </li> </ul>



## Exhibit 2: FHWA Recommended Crash Countermeasures (continued)

Crash Countermeasure	FHWA's Description	Key Resources (See FHWA's Web Site For More Helpful Resources)
<p><b>Medians and Pedestrian Crossing Islands in Urban and Suburban Areas</b></p> 	<p>Medians are areas between opposing lanes of traffic. They can be open or channelized to separate various road users. Pedestrian crossing islands are raised islands on a street to separate crossing pedestrians from motor vehicles. Both of these improve the safety benefits for pedestrians and vehicles.</p>	<ul style="list-style-type: none"> <li>✓ A Review of Pedestrian Safety Research in the United States and Abroad, p. 85-86 <a href="http://www.walkinginfo.org/library/details.cfm?id=13">http://www.walkinginfo.org/library/details.cfm?id=13</a></li> <li>✓ Pedestrian Facility User's Guide: Providing Safety and Mobility, p. 56 <a href="http://katana.hsrc.unc.edu/cms/downloads/PedFacility_UserGuide2002.pdf">http://katana.hsrc.unc.edu/cms/downloads/PedFacility_UserGuide2002.pdf</a></li> <li>✓ Guide for the Planning, Design, and Operation of Pedestrian Facilities, American Association of State Highway and Transportation Officials, 2004 [Available for purchase from AASHTO] <a href="https://bookstore.transportation.org/item/details.aspx?id=119">https://bookstore.transportation.org/item/details.aspx?id=119</a></li> </ul>
<p><b>Pedestrian Hybrid Beacon</b></p> 	<p>This is a pedestrian-activated warning device located on the roadside or on mast arms over midblock pedestrian crossings and consisting of two red lenses above a single yellow lens.</p>	<ul style="list-style-type: none"> <li>✓ A Review of Pedestrian Safety Research in the United States and Abroad <a href="http://www.walkinginfo.org/library/details.cfm?id=13">http://www.walkinginfo.org/library/details.cfm?id=13</a></li> <li>✓ Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations <a href="http://www.walkinginfo.org/library/details.cfm?id=54">http://www.walkinginfo.org/library/details.cfm?id=54</a></li> </ul>
<p><b>"Road Diet" (Roadway Reconfiguration)</b></p> 	<p>This classic roadway reconfiguration, or "road diet," involves converting an undivided four-lane roadway into three lanes made up of two through lanes and a center two-way left-turn lane. The roadway can then be reallocated for bike lanes, pedestrian crossing islands, and/or parking. Road diets have multiple safety and operational benefits for vehicles as well as pedestrians.</p>	<ul style="list-style-type: none"> <li>✓ Pedsafe: Pedestrian Safety Guide and Countermeasure Selection System, p. 62 <a href="http://www.walkinginfo.org/pedsafe/pedsafe_downloads.cfm">http://www.walkinginfo.org/pedsafe/pedsafe_downloads.cfm</a></li> <li>✓ Pedestrian Facility User's Guide: Providing Safety and Mobility, p. 53 <a href="http://katana.hsrc.unc.edu/cms/downloads/PedFacility_UserGuide2002.pdf">http://katana.hsrc.unc.edu/cms/downloads/PedFacility_UserGuide2002.pdf</a></li> <li>✓ FHWA Office of Safety Bicycle and Pedestrian Safety <a href="http://safety.fhwa.dot.gov/ped_bike/">http://safety.fhwa.dot.gov/ped_bike/</a></li> </ul>

## Summary

These crash countermeasures have been proven effective through efforts by the FHWA and State and local agencies. Installation transportation planners and engineers are encouraged to implement these corrective actions where applicable. After implementation, planners and engineers should reassess the location to determine effectiveness and the need for additional or alternate countermeasures.

It is important to remember that the countermeasures in this bulletin only address the traffic engineering solutions to crashes. Good driver education and law enforcement must be integrated in the entire solution process for the greatest effectiveness and benefit in reducing crashes and ultimately deaths and injuries.

## Contact Us

We can help your installation reduce crashes!

**Darren J. Guttman, P.E.**

Phone: 618-220-5218

**David G. Kirkpatrick**

Phone: 618-220-5252

**Thomas J. Mannino, P.E., PTOE**

Phone: 618-220-5249

**Brenda K. Roth, P.E., PTOE**

Phone: 618-220-5290

**Mickeal D. Carda, P.E.**

Phone: 618-220-5450

**David F. Clark, Jr.**

Phone: 618-220-7747

**Military Surface Deployment and  
Distribution Command**

**Transportation Engineering Agency**

1 Soldier Way

Scott Air Force Base, Illinois 62225-5006

DSN: 770-5252

Fax: 618-220-5125

E-mail: [army.sddc.safb.traffic@mail.mil](mailto:army.sddc.safb.traffic@mail.mil)

Web Site: <http://www.tea.army.mil> for pamphlets,  
bulletins, and studies

## Answers from page 2



There are many cases where a certain location may be crash-prone. There often are physical factors that can make a location more crash prone. Mitigation can be of a lesser magnitude such as removing a sight obstruction, or of a greater magnitude such as reconstruction of an intersection to provide more capacity and remove congestion (a leading cause of rear-end crashes).

Both of these situations are of intersections that were crash-prone. Their old configurations were delay prone and had sight distance, pedestrian, and safety issues. The locations were reconstructed from the original layout to add capacity and better serve the long-term needs of the community.



MR. BRUCE A. BUSLER, SES

Director, Transportation Engineering Agency

## DEPARTMENT OF THE ARMY

Military Surface Deployment

and Distribution Command

Transportation Engineering Agency

1 Soldier Way

Scott Air Force Base, Illinois 62225-5006

OFFICIAL BUSINESS

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Continuing Education	Phone	Web Site
Pennsylvania State University; The Pennsylvania Transportation Institute	(814) 865-4700	<a href="http://www.pti.psu.edu">www.pti.psu.edu</a>
University of Maryland; MD Transportation Technology Transfer Center	(301) 403-4623	<a href="http://www.ence.umd.edu/tttc">www.ence.umd.edu/tttc</a>
Georgia Institute of Technology	(404) 385-3501	<a href="http://www.gatech.edu">www.gatech.edu</a>
Northwestern University Center for Public Safety	(800) 323-4011	<a href="http://www.northwestern.edu/nucps/index.htm">www.northwestern.edu/nucps/index.htm</a>
Texas A&M University	(979) 845-3211	<a href="http://www.tamu.edu">www.tamu.edu</a>
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