SAFETY ANALYSIS GUIDELINES



August 2026

Engineering Manual Preamble

This manual provides guidance to administrative, engineering, and technical staff. Engineering practice requires that professionals use a combination of technical skills and judgment in decision making. Engineering judgment is necessary to allow decisions to account for unique site-specific conditions and considerations to provide high-quality products, within budget, and to protect the public health, safety, and welfare. This manual provides the general operational guidelines; however, it is understood that adaptation, adjustments, and deviations are sometimes necessary. Innovation is a key foundational element to advance the state of engineering practice and develop more effective and efficient engineering solutions and materials. As such, it is essential that our engineering manuals provide a vehicle to promote, pilot, or implement technologies or practices that provide efficiencies and quality products, while maintaining the safety, health, and welfare of the public. It is expected when making significant or impactful deviations from the technical information from these guidance materials, that reasonable consultations with experts, technical committees, and/or policy setting bodies occur prior to actions within the timeframes allowed. It is also expected that these consultations will eliminate any potential conflicts of interest, perceived or otherwise. MDOT Leadership is committed to a culture of innovation to optimize engineering solutions.

The National Society of Professional Engineers Code of Ethics for Engineering is founded on six fundamental canons. Those canons are provided below.

Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health, and welfare of the public.
2. Perform Services only in areas of their competence.
3. Issue public statement only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honorably, reasonably, ethically and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

If you require assistance accessing this information or require it in an alternative format, contact the Michigan Department of Transportation's (MDOT) Americans with Disabilities Act (ADA) coordinator at: Michigan.gov/MDOT-ADA.

Introduction

The purpose of a safety analysis is to scope improvements for traffic safety issues at site-specific and systemic levels. Safety analyses are incorporated into the planning, scoping, and design phases of the project development cycle and utilize a data-driven approach to identify site-specific crash patterns and high-risk roadway features to maximize safety benefit through optimal utilization of limited funds and resources.

A safety analysis is an inexact and subjective exercise that requires significant engineering judgment to be applied. There are tools, such as the Highway Safety Manual, that can normalize crash rates based on roadway attributes to determine if a facility is performing above, below, or at expectations based on the performance of other similar roadways. However, engineering judgment must still be applied to adequately assess the risk of future crashes that may result in fatalities and serious injuries and recommend safety countermeasures for mitigating that risk at a reasonable cost.

Three types of safety analysis are described in this guidance: Project Level, Design Exception/Variance, and Systemic.

Project-Level Safety Analysis

A Project-Level Safety Analysis (Task 2155 Request/Perform Safety Analysis for EPE/Design) is required for all projects unless the TSC or Region Traffic and Safety Engineer determines that the project work type does not provide an opportunity to make road safety improvements (see Section 14.24 of the Road Design Manual (RDM)). A project-level safety analysis should be completed prior to scope verification and utilize the most recent five (5) years of crash data available.

A *Crash Analysis and Safety Review Template* is available on the Traffic & Safety SharePoint to assist TSC or Region Traffic and Safety Engineers with completing project level safety analyses in a memo format. The template may be provided to prequalified consultants by MDOT staff. The template should be utilized to ensure that all elements of a project-level safety analysis are captured, which include:

1. General project description and location information
2. Existing roadway characteristics
3. Crash summary
4. Fatal and serious injury crash information
5. Recommendations

The project-level safety analysis should assess the following crash characteristics to determine the risk for future fatal and/or serious injury crashes in the existing condition absent engineering-level mitigation:

- Crash Patterns
- Crash Frequency
- Crash Concentrations
- Crash Severity

The analysis should also examine the presence of existing high-risk roadway features that are more often associated with fatal and/or serious injury crashes (see the Systemic Analysis section later in this Guidance)

If it is determined that a reasonable risk of future fatal and/or serious injury crashes exists based on crash history and/or the presence of high-risk roadway features, the analysis should include recommendations for safety countermeasures that target the specific risk elements identified. Safety countermeasures should be achievable through the project's general scope of work and funding template. If a change to the general scope of work or funding template is needed to achieve a specific safety countermeasure, it should be discussed amongst the System Manager, Region Traffic, Safety, and Operations Engineer, and Project Manager prior to including the recommendation.

The Project Manager, in consultation with the project team, will determine which recommended safety countermeasures will be included in the project's scope of work, and the most appropriate funding source(s) to support the recommendations. If a recommendation is not included in the project's scope of work, the Project Manager should document the reason(s).

Design Exception/Variance Safety Analysis

A site-specific Highway Safety Manual (HSM) analysis is required for any proposed Design Exception (DE) or Design Variance (DV). If a specific HSM model does not exist for that roadway type, then an analysis of existing crash data associated with the impacted geometric element should be completed instead, using the most recent five (5) years of crash data available in Roadsoft.

The analysis should be performed for the proposed limits of the DE/DV only, and not for the entire project limits (unless the DE/DV is being requested for the entire project limits).

After the scope verification meeting is held and the project scope has been agreed upon, the Project Manager should identify any DEs or DVs that will be utilized. A Design Exception Request form or a Design Variance Request form should then be completed.

Links to these forms are below.
Design Exception Request
Design Variance Request

The Project Manager must consult with the Geometrics Unit of the Design Division and the TSC Traffic and Safety Engineer when identifying and developing justification for Design Exceptions or Variances. Section 3.08.01E of the RDM describes DE/DV applicability and the corresponding levels of documentation and approval.

A *DE/DV Safety Analysis Template* is available on the Traffic & Safety SharePoint to assist TSC or Region Traffic and Safety Engineers with completing DE/DV safety analyses in a memo format. The template may be provided to prequalified consultants by MDOT staff. Table **A** outlines the crash types associated with geometric features to which a DE/DV may apply.

Table A: Crash Types Associated with Geometric Features

GEOMETRIC FEATURE	ASSOCIATED CRASH TYPES
Lane Width	Fixed Object, Overturn, Head On, Sideswipe
Shoulder Width	Fixed Object, Overturn, Pedestrian, Bicycle
Horizontal Curve Radius	Fixed Object, Overturn, Head On, Sideswipe
Superelevation Rate	Fixed Object, Overturn, Head On, Sideswipe
Stopping Sight Distance (Horizontal and Vertical)	Rear End, Fixed Object, Overturn, Head On, Sideswipe, Angle, Head On Left Turn, Animal*
Maximum Grade	Rear End, Fixed Object, Overturn, Sideswipe, Head On
Cross Slope (Too Flat)	Rear End, Wet (All Types), Icy (All Types)
Cross Slope (Too Steep)	Fixed Object, Overturn, Head On, Sideswipe
Vertical Clearance	High-Load Hits
Superelevation Transition	Fixed Object, Overturn, Head On, Sideswipe
Ramp Acceleration / Deceleration Length	Rear End, Fixed Object, Overturn, Sideswipe
Parabolic / Split Pane Insertion or Retention	*See Cross Slope*
Ramp Design Speed Less than the Lower Range Speed in AASHTO Table 10-1	Fixed Object, Overturn, Sideswipe
Ramp Vertical Design Speed Less than Horizontal Design Speed	Rear End, Fixed Object, Overturn, Sideswipe

** At night, the available sight distance through sag vertical curves is largely determined by headlight illumination distance. Therefore, when reviewing crashes in relation to sag vertical curves, particular attention should be paid to night-time crashes, including animal collisions. A high percentage of night-time crashes could indicate a crash pattern related to insufficient*

stopping sight distance. While animal collisions are not generally included in crash analyses due to the large uncertainty as to their causes and/or exact locations, they should not be summarily dismissed, either. Animal crashes can be taken together with the crash data set as a whole and can sometimes help identify crash patterns specifically related to restricted sight distance.

Systemic Safety Analysis

Systemic safety analysis is a proactive safety approach that focuses on evaluating an entire roadway network using a defined set of criteria. It examines crash history on an aggregate basis to identify high-risk roadway characteristics, rather than examining high-crash locations through site analysis.

A systemic safety analysis identifies crash types and roadway characteristics that together contribute to fatalities and serious injuries within a defined boundary (e.g., state, region, county, city, corridors). For instance, a systemic safety analysis performed for a specific MDOT region may reveal that Angle crashes are a significant contributor to fatalities and serious injuries. Further analysis may reveal that fatal and serious injury Angle crashes are most prevalent at 2-way stop-controlled intersections with approach speeds in excess of 45 miles per hour, and that the most common mistake made by drivers at those locations is failing to yield to cross traffic after they have already stopped (stop and proceed action). This level of systemic safety analysis better enables targeted prioritization of locations and selection of safety countermeasures, as well as a better understanding of high-risk roadway features, which is especially important when funds/resources are limited.

Systemic safety analysis relates fatal and serious injury crash types to roadway characteristics, such as roadway classification, speed limit, AADT, number of lanes, lane widths, shoulder widths, roadside condition, horizontal alignment (curved vs. tangent), intersection control type, presence (or lack thereof) of existing safety features (e.g., rumble strips, curve warning signs), facilities (or lack thereof) for vulnerable road users, and many others. The analysis reveals trends, and results in an enhanced ability to assess the risk of future fatalities and serious injuries occurring on a certain roadway based not only on its crash history but also on its characteristics.

The identification of roadway characteristics, or combinations of roadway characteristics, that are present for a significant portion of an area's fatal and serious injury crashes (and thus deemed higher risk for yielding future fatal and serious injury crashes), should be the first step in developing a safety plan for that area. The next step is to identify potential safety countermeasures (both proven and new ideas) for mitigating those risks and for prioritizing segments/intersections for treatment. Additionally, safety plans should identify strategies for implementing safety improvements beyond only those that are funded through the various "Safety" templates. For example, a region may identify in their Toward Zero Deaths Plan that lane departure crashes to the right are over-represented on rural, undivided roadways with

speed limits above 45 mph, AADT above 3,000, and paved shoulder widths less than 6 feet; and incorporate a strategy to install edgeline corrugations with all resurfacing projects on roadways having those characteristics.

The Safety Call for Projects Instructions detail how systemic analyses should be utilized to support project submittals during the Safety Call for Projects process.