April 4, 2022

Attachment 1 – Performance-Based Decision-Making Guidelines using the Highway Safety Manual

The purpose of a Highway Safety Manual (HSM) analysis is to provide a quantitative performance-based safety analysis that facilitates the Department's safety-first goals and objectives in the decision-making process throughout project development which includes eliminating fatal and serious injury collisions. The HSM can facilitate design and operational decisions for projects on the State Highway System (SHS) by providing a quantitative safety assessment of how changes to those features affect predicted collisions. Prior to the HSM, only a subjective assessment of changes to design and operational features was possible using engineering judgement and experience. In effect, the HSM can provide a stronger focus on the potential safety impacts of the decisions that are made in project development.

Overview

The HSM is organized into four parts:

- Part A – Introduction, Human Factors and Fundamental knowledge.
- Part B – Roadway Safety Management Process.
- Part C – Predictive Methods for Rural Two-lane Highways, Rural Multilane Highways, Urban and Suburban Arterials, and Freeways and Ramps.
- Part D – Crash Modification Factors.

Roles and Responsibilities:

Headquarters (HQ) Division of Design (DOD)

- Designate and train HQ HSM Subject Matter Experts (SMEs).
- Provide technical assistance in HSM applications to District Design staff.
- Coordinate and collaborate with the HQ Safety Programs, and District Design HSM SMEs to:
    - Develop technical expertise in HSM analysis methods;
    - Implement the use of the HSM;
    - Support District Design's use of the HSM for project delivery; and
    - Develop and maintain guidance and tools to facilitate the use of the HSM throughout project development.

HQ Division of Safety Programs

- Designate and train HQ HSM SMEs.
- Provide technical assistance in HSM applications to District Traffic Safety, and Traffic Operations staff.

- Coordinate and collaborate with HQ Design, and District Traffic Operations and Traffic Safety SMEs to:
  - Develop technical expertise in HSM analysis methods;
  - Implement the use of the HSM; and
  - Support the District's Safety Program's use of the HSM.
- Develop and maintain California collision cost information such that it can be applied directly to HSM tools outputs and California-specific safety performance functions and crash modification factors. Communicate updates to collision cost information to HQ DOD.
- Coordinate with HQ DOD to update guidance and tools when California specific calibration factors or safety performance functions and crash modification factors are developed.

Project Delivery Team (PDT)

- Determine the need and usefulness of a HSM analysis for making performance-based decisions throughout project delivery.
- Consult with the District Design and Traffic Safety Program's HSM SMEs, as needed.
- Weigh and balance the overall impacts to the State through consideration of tradeoffs associated with the performance-based safety analysis.

District Division of Design

- Design management is to designate District HSM SMEs and see that they are trained and resourced to:
  - Coordinate and collaborate with the HQ DOD, HQ Division of Safety Programs, and District Traffic Operations and Traffic Safety HSM SME(s);
  - Train District staff; and
  - Provide technical assistance to support HSM application.
- Determine when an HSM analysis is required, if and how it can be applied to a project, and review the HSM analysis.
- Provide needed geometric data required for District (Design, Traffic Operations, or Traffic Safety) to perform the HSM modeling.
- Review an HSM analysis for projects funded by others and performed by other Divisions.
- Support PDTs as needed.
- Request/include necessary resources to perform or review a pre-modeling analysis, HSM modeling, post-modeling analysis and documentation.

District Division of Traffic Operations and Division of Safety Programs/Traffic Safety

- Traffic Management is to designate District HSM SME's and see that they are trained and resourced to:
  - Coordinate and collaborate with the HQ DOD, HQ Division of Safety Programs, and District Design HSM SME(s);
  - Train District staff; and
  - Provide technical assistance for HSM applications to support Capital Outlay Support (COS) and safety project delivery, encroachment permit projects, and Local Development-Intergovernmental Review (LD-IGR) projects.
- Provide needed traffic related data (such as, but not limited to, Traffic Accident Surveillance and Analysis System (TASAS) data, Traffic Collison Reports, AADT, signal phasing, traffic delay, etc.) needed for District (Design, Traffic, or Safety) to perform HSM modeling and analysis on all projects, including non-safety projects.
- Support PDTs, as needed.
- Request/include necessary resources to perform or review a pre-modeling analysis, HSM modeling, post-modeling analysis, and documentation.
- Review an HSM analysis for Local Development - Intergovernmental Review (LD-IGR) Safety Reviews if provided as part of the LD-IGR Traffic Investigation Report.
- Determine when an HSM analysis is required, if and how it can be applied to a project, and review the HSM analysis.
- Review an HSM analysis for projects funded by others and performed by other Divisions.

Engineer in Responsible Charge of Project Development in Current Phase

- Conduct an HSM analysis in consultation with the District Design, Traffic Operations, and Traffic Safety HSM SMEs.
- Document outcomes of the HSM analysis, or why an HSM analysis was not applicable, in the appropriate project document (e.g., project approval document, Design Standard Decision Document (DSDD), HSM analysis methodology, and/or project history file (see Limitations below)).

Project Application:

The HSM Part C methodology can be used as a tool to predict collisions, however, as with any tool, limitations may apply which could preclude its use. For the HSM, these limitations may include traffic volume limits or number of lane limits, a facility type that is not yet included, or certain geometric or operational features that

cannot be explicitly analyzed. The HSM is limited on the facility types that can be analyzed when comparing the HSM methodology to the Highway Safety Improvement Program (HSIP) methodology; however, the HSM can analyze more geometric features. Therefore, the HSIP methodology is currently used to qualify safety projects and the HSM methodology may be used in the future to supplement this analysis. The HSIP methodology does not replace an HSM analysis for projects in Project Approval & Environmental Document (PA&ED) or Plans, Specifications, and Estimates (PS&E) phases.

Where the HSM Part C predictive methods can be applied, the HSM shall be used for all projects on the SHS regardless of project sponsor or funding source, if it is proposing any of the following:

- Nonstandard design feature(s).
- A geometric or operational feature that varies from the existing condition or from other project alternatives.
- New or modification to an interchange as part of the alternative selection process and Interstate New Access Report or Modified Access Report.

Analysis:

The HSM can predict collision performance using Safety Performance Functions (SPFs). The SPFs presented in the HSM are not California-specific, although California data was also used in some instances, and have been derived from detailed analysis of Traffic Collision Reports across the country using before/after analysis of select safety countermeasures and their impact on reducing fatal, injury, serious injury and property damage only collision types. HSM-developed SPFs should be used until California-specific information is available for use for the project types described in this document.

HSM Part C method analysis tools should be used for the following types of evaluations:

- Comparison between project alternatives for project alternative selection: difference in number of fatal and injury collisions, Cost to the State, and Benefit/Cost (B/C) ratio.
- Comparison between meeting standard and a proposed nonstandard geometric feature for a DSDD: difference in number of fatal and injury collisions, B/C ratio, net value, or Cost to the State.
- Trade-off analysis to find the most effective combination of geometric elements that fit within project constraints.

HSM Part D methodology applies to Crash Modification Factors (CMFs) outside of Part C (e.g. Part D of the HSM), and includes FHWA's CMF Clearinghouse (http://www.cmfclearinghouse.org) among other resources. The CMF

Clearinghouse is an extensive, searchable, and frequently updated database of published CMFs based on completed transportation-safety related research. A CMF from the CMF Clearinghouse should be used only when there is a clear understanding of its origins and limitations.

For application of a Part D CMF to projects covered in this Attachment 1, all the following criteria must be met:

- Used to overcome the facility types limitations included in the HSM (e.g., added ability to model a two-way left-turn lane on a rural 4-lane facility, or to model a single-lane roundabout alternative, etc.)
- Must come from the CMF Clearinghouse or a Caltrans-specific preapproved CMF list developed with the HSM methodology.
- For a quantitative analysis, a Part D CMF must be applied to the output of a Part C method analysis.
- The District Design and Traffic Safety SME's both concur on its intended application.
- Used singularly – only apply one Part D CMF to a roadway segment or intersection at a time.
- The standard error of the CMF is applied appropriately, to provide a numerical range of potential effects on collisions.
- Use of a Part D CMF, application calculations, and meeting the above criteria are documented in the appropriate document (e.g., DSDD, HSM analysis methodology, project history file, etc.).

Limitations:

The HSM uses predictive methods to incorporate geometric and operational configurations using traffic volumes and other factors as a basis for analysis. Utilizing predictive methods outside the boundaries for which the tool was developed may bring the validity of the results obtained into question.

Therefore, understanding the limitations of the methods presented in the HSM and documenting project decisions are critical to a successful analysis.

When the HSM predictive methods cannot be applied to design alternatives, nonstandard features, or only a portion of the project can be analyzed, it should be documented in the appropriate report such as the project approval document and/or the DSDD and the project history file.