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Use and Misuse of Crash Modification Factors

Fun, fun, fun 'till your daddy takes the T-bird away

Larry Hagen, P.E., PTOE

"Driving Down Fatalities Through Knowledge Sharing"

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Application and Science of Crash Reduction Factors

Fun, fun, fun 'till your daddy takes the T-bird away

Larry Hagen, P.E., PTOE

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Use and Misuse of Crash Modification Factors

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What is a CMF?

A CMF is one of the many TLA's that we use in traffic engineering. Here are some others:

- ADT
- HCM
- HSM
- MOE

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TLA

Three Letter Acronym

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- HCM
- HSM
- MOE

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ADT

Average Daily Traffic

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HCM

Highway Capacity Manual

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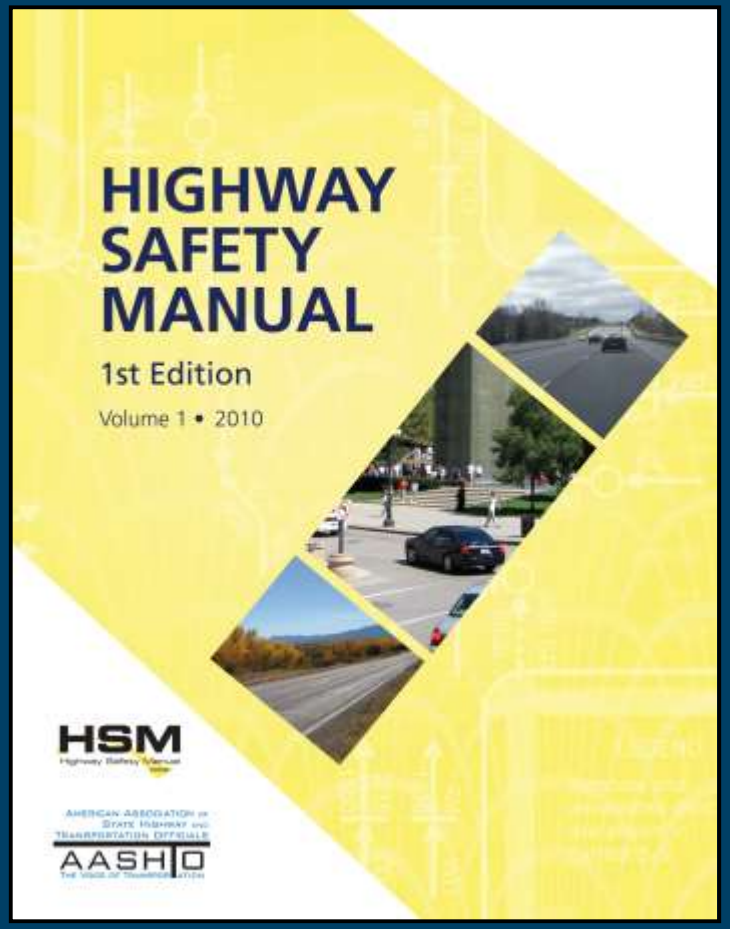
HSM

Highway Safety Manual



"Driving Down Fatalities Through Knowledge Sharing"

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MOE

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MOE

Measure Of Effectiveness

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CMF

Crash Modification Factor

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CMF is a MOE

A Crash Modification Factor is a measure of how effective you are at modifying the crash rate.

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CRF

Crash Reduction Factor

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CRF is a MOE

The Crash Reduction Factor is a measure of how effective you are at reducing crashes.

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CRF vs CMF

- CRF

  A Crash Reduction Factor is an estimate of the percentage reduction in crashes due to a particular countermeasure.

- CMF

  A Crash Modification Factor is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure.

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CRF vs CMF

	CRF	CMF
Range of values	$-\infty < CRF \leq 1.0$	$0 \leq CMF < \infty$
No change in crashes	0	1.0
Eliminate all crashes	1.0	0
Double the number of crashes	-1.0	2.0
Half the number of crashes	0.5	0.5
15% less crashes	0.15	0.85
15% more crashes	-0.15	1.15

$$CMF = 1 - CRF$$

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Where do I find CRF's & CMF's?

- Florida DOT CRF's
- Highway Safety Manual
- CMF Clearinghouse

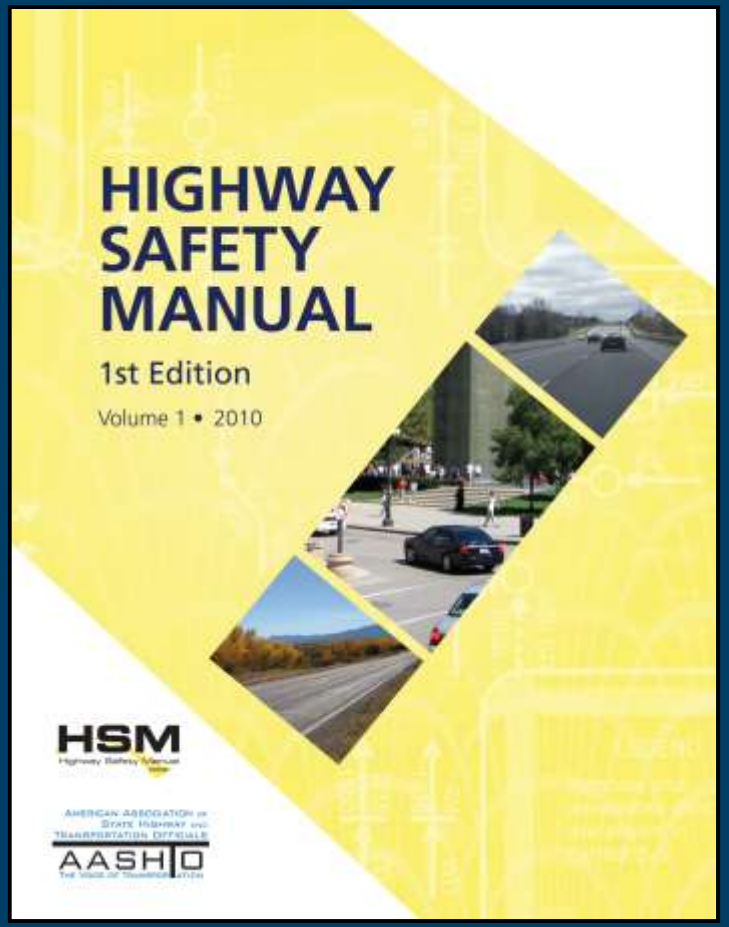
www.cmfclearinghouse.org

Florida DOT CRF's

- Crash Reduction Factors from studies in Florida
- Produced by Lehman Center at FIU
- Crash Reduction Analysis System Hub (CRASH)
- Updated in 2005
- Update to Peter Hsu's work in graduate school at UF

Highway Safety Manual

- Tables in the HSM contain CMF's
- Must convert to CRF's if that is what you need
- NOTE: there are separate CMF's for the predictive models and for project analysis
- Typically, the CMF's for the predictive models should NOT be used for other purposes and the other CMF's should not be used with the predictive models



Crash Modification Factors C

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CMF
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Search for:

enter search term(s)

in

Countermeasure Name

Need Help?

Search CMFs

Find out more about the Star Quality Ratings for CMFs

Read more about the star quality rating applied to CMFs in the Clearinghouse. The star rating is based on a scale (1 to 5), where a 5 indicates the highest or most reliable rating.

A crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. The Crash Modification Factors Clearinghouse houses a Web-based database of CMFs along with supporting documentation to help transportation engineers identify the most appropriate countermeasure for their safety needs. Using this site, you can search to find CMFs

Recently Added CMFs

Improve pavement friction (increase skid resistance)

CMF: 0.866

CRF: 13.4

Crash type: Rear end

Installation of a High intensity Activated crossWalK (HAWK) pedestrian-activated beacon at an intersection

CMF: 0.309

CRF: 69

Add Two-Way-Left-Turn-Lane (TWLTL) to the major approach of an unsignalized 3-leg intersection

CMF: 0.69

CRF: 31

start | Crash Modification F... | Inbox - Microsoft Ou... | 2 Windows Explorer | Microsoft PowerPoint... | 7:21 AM

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WARNING!

ALWAYS use caution when looking up or applying CMF's or CRF's

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HSM Predictive Models

Table 1 Facility Types with Safety Performance Functions

HSM Chapter	Undivided Roadway Segments	Divided Roadway Segments	Intersections			
			Stop Control on Minor Leg(s)		Signalized	
			3-Leg	4-Leg	3-Leg	4-Leg
10 Rural Two-Lane Roads	✔		✔	✔		✔
11 Rural Multi-lane Highways	✔	✔	✔	✔		✔
12 Urban and Suburban Arterials	✔	✔	✔	✔	✔	✔

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HSM Predictive Models

- Safety Performance Function for facility type
- Crash Modification Factors (Functions)
- Calibration Factor
- EB Adjustment

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HSM Predictive Models

- **What are Safety Performance Functions?**
- Mathematical Regression Models for Roadway Segments and Intersections:
- Developed from data for a number of similar sites
- Developed for specific site types and “base conditions”
- Function of only a few variables, primarily AADT
- Used to calculate the expected crash frequency (crashes/year) for a set of base geometric and traffic control conditions
- **Purpose of Crash Modification Factors**
- Adjusts the calculated SPF predicted value for base conditions to actual or proposed conditions
- Accounts for the difference between base conditions and site specific conditions

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HSM Predictive Models

SPF Prediction Model for Base Conditions:

Rural Two-Lane Roadway Segments

$$N_{spf\text{-}rs} = AADT \times L \times 365 \times 10^{-6} \times e^{(-0.312)}$$

$N_{spf\text{-}rs}$ = predicted total crash frequency for roadway segment base conditions (crashes/year)

AADT = average annual daily traffic volume (vpd)

L = length of roadway segment (miles)

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HSM Predictive Models

Base Conditions for Rural Two-Lane Roadway Segments:

Lane Width:	12 feet
Shoulder Width:	6 feet
Shoulder Type:	Paved
Roadside Hazard Rating:	3
Driveway Density:	≤5 driveways/mile
Grade:	≤ 3%
Horizontal Curvature:	None
Vertical Curvature:	None
Centerline rumble strips:	None
TWLTL, climbing, or passing lanes:	None
Lighting:	None
Automated Speed Enforcement:	None

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HSM Predictive Models

Apply CMFs to the SPF Base Model

$$N_{predicted\text{-}rs} = N_{spf\text{-}rs} \times (CMF_{1r} \ldots CMF_{xr})\, C_r$$

Where:

- $N_{predicted\text{-}rs}$ = predicted average crash frequency for an individual roadway for a specific year (crashes per year)
- $N_{spf\text{-}rs}$ = predicted average crash frequency for base conditions for an individual roadway segment (crashes per year)
- $CMF_{1r} \ldots CMF_{xr}$ = Crash Modification Factors for individual design elements
- C_r = calibration factor

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HSM Predictive Models

Crash Modification ~~Factor~~ Function - Lane Width

Table 10-8. CMF for Lane Width on Roadway Segments (CMF_{ra})

Lane Width	AADT (veh/day)		
	< 400	400 to 2000	> 2000
9-ft or less	1.05	$1.05+2.81\times10^{-4}(AADT-400)$	1.50
10-ft	1.02	$1.02+1.75\times10^{-4}(AADT-400)$	1.30
11-ft	1.01	$1.01+2.5\times10^{-5}(AADT-400)$	1.05
12-ft or more	1.00	1.00	1.00

NOTE: The collision types related to lane width to which this CMF applies include single-vehicle run-off-the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe crashes.

$$CMF_{1r} = (CMF_{ra} - 1.0)p_{ra} + 1.0$$

- P_{ra} = proportion of related crashes. Default value = 0.574

District 7 has good data: use CDMS to get factors

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WARNING!

Take caution when looking up or applying CMF's or CRF's

~~ALWAYS~~ use previous slide is **ONLY** applicable for use with the predictive model for rural two-lane roadway segments!

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HSM Predictive Models

Multiplication of CMFs in Part C

In the *Part C predictive method, an SPF estimate is multiplied by a series of CMFs* to adjust the estimate of crash frequency from the base condition to the specific conditions present at a site. The CMFs are multiplicative because the effects of the features they represent are **presumed to be independent**. However, little research exists regarding the independence of these effects, but this is a reasonable assumption based on current knowledge. The use of observed crash frequency data in the EB Method can help to compensate for bias caused by lack of independence of the CMFs. As new research is completed, future HSM editions may be able to address the independence (or lack of independence) of these effects more fully.

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HSM CMF's

Multiplication of CMFs in Part D

CMFs are also used in estimating the anticipated effects of proposed future treatments or countermeasures (e.g., in some of the methods discussed in Section C.8). The limited understanding of interrelationships between the various treatments presented in Part D requires consideration, especially when more than three CMFs are proposed. If CMFs are multiplied together, it is possible to overestimate the combined affect of multiple treatments when it is expected that more than one of the treatments may affect the same type of crash. The implementation of wider lanes and wider shoulders along a corridor is an example of a combined treatment where the independence of the individual treatments is unclear, because both treatments are expected to reduce the same crash types. When CMFs are multiplied, the practitioner accepts the assumption that the effects represented by the CMFs are independent of one another. Users should exercise engineering judgment to assess the interrelationship and/or independence of individual elements or treatments being considered for implementation.

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HSM CMF's

Compatibility of Multiple CMFs

Engineering judgment is also necessary in the use of combined CMFs where multiple treatments change the overall nature or character of the site; in this case, certain CMFs used in the analysis of the existing site conditions and the proposed treatment may not be compatible. An example of this concern is the installation of a roundabout at an urban two-way stop-controlled or signalized intersection. The procedure for estimating the crash frequency after installation of a roundabout (see *Chapter 12) is to estimate the average crash frequency for the existing site conditions* (as a SPF for roundabouts in currently unavailable) and then apply an CMF for a conventional intersection to roundabout conversion. Installing a roundabout changes the nature of the site so that other CMFs applicable to existing urban two-way stop controlled or signalized intersections may no longer be relevant.

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WARNING!

You ALWAYS use extreme care and caution when combining CMF's!

NEVER try to combine CRF's!

ALWAYS use caution when looking up or applying CMF's or CRF's

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Combining CRFs

- Just DON'T do it!
- Certainly not additive

25% + 35% ≠ 60%
for CRFs

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Combining CRFs

- Just DON'T do it!
- Certainly not additive
- Convert to CMFs
- Multiply if applicable

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Combining CMFs

- Multiply if applicable
- Consider independence
- No more than three

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Find out more about the Star Quality Ratings for CMFs

Read more about the star quality rating applied to CMFs in the Clearinghouse. The star rating is based on a scale (1 to 5), where a 5 indicates the highest or most reliable rating.

A crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. The Crash Modification Factors Clearinghouse houses a Web-based database of CMFs along with supporting

Recently Added CMFs

Improve pavement friction (increase skid resistance)

CMF: 0.866

Installation of a High intensity Activated crossWalK (HAWK) pedestrian-activated beacon at an

Convert minor-road stop control to all-way stop control

CMF: 0.319

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enter search term(s)

in

Countermeasure Name

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CMFs in Practice

Learn how CMFs are being used in situations such as safety management, road safety audits, and design exceptions, illustrated with demonstrations of real-world case studies.

CMF

CRASH MODIFICATION FACTORS IN PRACTICE

1 2 3 4

A crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. The Crash Modification Factors Clearinghouse houses a Web-based database of CMFs along with supporting documentation to help transportation engineers identify the most appropriate countermeasure for their safety needs. Using this site, you can search to find CMFs or submit your own CMFs to be included in the clearinghouse.

Recently Added CMFs

Improve pavement friction (increase skid resistance)

CMF: 0.866

CRF: 13.4

Crash type: Rear end

Crash severity: All

Installation of a High intensity Activated crossWalK (HAWK) pedestrian-activated beacon at an intersection

CMF: 0.309

CRF: 69

Crash type: Vehicle/pedestrian

Convert minor-road stop control to all-way stop control

CMF: 0.319

CRF: 68.1

Crash type: All

Crash severity: All

U.S. Department of Transportation Federal Highway Administration

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

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Installation of a High intensity Activated crossWalK (HAWK) pedestrian-activated beacon at an intersection

Description: Installation of a High intensity Activated crossWalK (HAWK) pedestrian-activated beacon at an intersection

Prior Condition: Minor-road stop-controlled intersection

Category: Pedestrians

Study: Safety Effectiveness of the HAWK Pedestrian Crossing Treatment, Fitzpatrick, K., and Park, E.S., 2010

Star Quality Rating:	★★★☆☆ [View score details]

Crash Modification Factor (CMF)	
Value:	0.309
Adjusted Standard Error:	
Unadjusted Standard Error:	0.156

Crash Reduction Factor (CRF)	
Value:	69 *(This value indicates a **decrease** in crashes)*

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Star Quality Rating

Submitted studies are ranked in the following categories:

Relative Rating	Excellent	Fair	Poor
Study Design	Statistically rigorous study design with reference group or randomized experiment and control	Cross sectional study or other coefficient based analysis	Simple before / after study
Sample Size	Large sample, multiple years, diversity of sites	Moderate sample size, limited years, and limited diversity of sites	Limited homogeneous sample
Standard Error	Small compared to CRF	Relatively large SE, but confidence interval does not include zero	Large SE and confidence interval includes zero
Potential Bias	Controls for all sources of known potential bias	Controls for some sources of potential bias	No consideration of potential bias
Data Source	Diversity in States representing different geographies	Limited to one State, but diversity in geography within State (e.g., CA)	Limited to one jurisdiction in one State
	2 points	1 point	0 points

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Star Quality Rating

- Final quality rating is based on weighted score:

Score = (2*study design) + (2*sample size) + standard error + potential bias + data source

- Star rating based on the score

Score	Star Rating
14 (max possible)	5 Stars
11 – 13	4 Stars
7 – 10	3 Stars
3 – 6	2 Stars
1 – 2	1 Star
0	0 Stars

Installation of a High intensity Activated crossWalK (HAWK) pedestrian-activated beacon at an intersection

Description: Installation of a High intensity Activated crossWalK (HAWK) pedestrian-activated beacon at an intersection

Prior Condition: Minor-road stop-controlled intersection

Category: Pedestrians

Study: Safety Effectiveness of the HAWK Pedestrian Crossing Treatment, Fitzpatrick, K., and Park, E.S., 2010

Star Quality Rating:	★★★☆☆ [View score details]

Crash Modification Factor (CMF)	
Value:	0.309
Adjusted Standard Error:	
Unadjusted Standard Error:	0.156

Crash Reduction Factor (CRF)	
Value:	69 *(This value indicates a **decrease** in crashes)*

Value:	69 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	
Unadjusted Standard Error:	15.6

Applicability	
Crash Type:	Vehicle/pedestrian
Crash Severity:	All
Roadway Types:	Not Specified
Number of Lanes:	4 to 6
Road Division Type:	All
Speed Limit:	30 to 40 mph
Area Type:	Urban and suburban
Traffic Volume:	
Time of Day:	All
If countermeasure is intersection-based	

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Search for:

HAWK

in

Countermeasure Name

Need Help?

Search CMFs

A crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. The Crash Modification Factors Clearinghouse houses a Web-based database of CMFs along with supporting

Recently Added CMFs

Improve pavement friction (increase skid resistance)

CMF: 0.866

Installation of a High intensity Activated crossWalK (HAWK) pedestrian-activated beacon at an

Install raised median

CMF: 0.61

CRF: 39

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CRASH MODIFICATION FACTORS CLEARINGHOUSE

Search Results

There were 3 CMFs returned for your search on "**HAWK**". [modify your search].

Having trouble deciding between similar CMFs? Check out our FAQs.

Star Quality Rating

- 1 (0)
- 2 (0)
- 3 (2)
- 4 (1)
- 5 (0)

Crash Type

Crash Severity

Results Control: Collapse All | Expand All

Click on the links below to expand individual categories.

Category: Pedestrians (3)

There were 3 CMFs returned for your search on "**HAWK**". [modify your search].

Having trouble deciding between similar CMFs? Check out our FAQs.

- Star Quality Rating
  - 1 (0)
  - 2 (0)
  - 3 (2)
  - 4 (1)
  - 5 (0)
- Crash Type
- Crash Severity
- Roadway Type
- Area Type
- Intersection Type
- Intersection Geometry
- Traffic Control
- In HSM

Filter Results

Results Control: Collapse All | Expand All

Click on the links below to expand individual categories.

Category: Pedestrians (3)

Countermeasure: Installation of a High intensity Activated crossWalK (HAWK) pedestrian-activated beacon at an intersection

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
0.712	29	★★★★☆	All	All	Urban and suburban	Fitzpatrick, K., and Park, E.S., 2010	The authors of th study ... [read mo
0.849	15	★★★☆☆	All	Fatal,Serious injury	Urban and suburban	Fitzpatrick, K., and Park, E.S., 2010	The authors of th study ... [read mo
0.309	69	★★★☆☆	Vehicle/pedestrian	All	Urban and suburban	Fitzpatrick, K., and Park, E.S., 2010	The authors of th study ... [read mo

How do I choose between CMFs in my search results that have the same star rating but different CMF values?

It's true that two or more CMFs for a particular countermeasure may have the same star rating but differing CMF values. It will be necessary for you to examine the information related to the applicability of the CMFs to determine how they differ. This could involve examining the brief data shown on the search results page (i.e., crash type, crash severity, roadway type, and area type) or looking at all the information about the CMFs by viewing the CMF details page for each one.

You should select the CMF that is most applicable to the situation in which you would like to apply the CMF (i.e., the characteristics associated with the CMF should closely match the characteristics of the scenario at hand). For example, CMFs often vary by crash type and crash severity. While it is useful to determine the change in crashes by type and severity, this should only be done when applicable CMFs are available for the specific crash type and severity of interest.

The figure below shows a snapshot of results for the countermeasure of "Installation of left-turn lane on single major road approach". You can see that the three CMFs listed in this figure all have 5-star ratings. However, the CMF values (0.65, 0.71, and 0.91) are all different.

- Countermeasure: Installation of left-turn lane on single major road approach

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type	Reference
0.65 [B]	35	★★★★★	All	Fatal,Serious Injury,Minor Injury	Not specified	Rural	Harwood et al., 2002
0.71 [B]	29	★★★★★	All	Fatal,Serious Injury,Minor Injury	Not specified	Urban	Harwood et al., 2002
0.91 [B]	9	★★★★★	All	Fatal,Serious Injury,Minor Injury	Not specified	Urban	Harwood et al., 2002

From this initial view of the search results, it is relatively easy to tell the difference between the first CMF and the other two. Although all three are similar in crash type, crash severity, and roadway type, the first one (CMF of 0.65) is identified as being developed for a "Rural" area type, whereas the other two were developed for an "Urban" area type.

approach". You can see that the three CMFs listed in this figure all have 5-star ratings. However, the CMF values (0.65, 0.71, and 0.91) are all different.

- Countermeasure: Installation of left-turn lane on single major road approach

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type	Reference
0.65 [B]	35	★★★★★	All	Fatal,Serious Injury,Minor Injury	Not specified	Rural	Harwood et al., 2002
0.71 [B]	29	★★★★★	All	Fatal,Serious Injury,Minor Injury	Not specified	Urban	Harwood et al., 2002
0.91 [B]	9	★★★★★	All	Fatal,Serious Injury,Minor Injury	Not specified	Urban	Harwood et al., 2002

From this initial view of the search results, it is relatively easy to tell the difference between the first CMF and the other two. Although all three are similar in crash type, crash severity, and roadway type, the first one (CMF of 0.65) is identified as being developed for a "Rural" area type, whereas the other two were developed for an "Urban" area type.

However, all information given on the search results page is identical for the second and third CMF. Therefore, it is necessary to examine the details of each CMF (by clicking on the CMF value to go to the CMF details page). When the details of each CMF are examined, it can be seen that the CMF of 0.71 is intended for stop-controlled intersections, and the CMF of 0.91 is intended for signalized intersections.

It may be the case that two CMFs are exactly the same with respect to crash and roadway applicability. In these cases, it will be necessary to examine some of the other fields related to how and where the CMF was developed, such as:

1. **Score details**. The reviewers who established the star quality rating did so by giving scores of excellent, fair, or poor to five categories: study design, sample size, standard error, potential bias, and data source. Many CMFs in the Clearinghouse are accompanied by details of the scores behind the star rating as shown in the image below.

Frequently Asked Questions

- About CMFs
- **FAQs**
- Glossary
- Star Quality Rating
- Relationship to HSM
- CMF Most Wanted List
- Submit a CMF Research Need

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Search Results

There were 67 CMFs returned for your search on "**Protected left turn**". [modify your search].

Having trouble deciding between similar CMFs? Check out our FAQs.

Overwhelmed by too many results? See our Search Tips.

Star Quality Rating

- 1 (11)
- 2 (19)
- 3 (14)
- 4 (16)
- 5 (7)

Crash Type

Crash Severity

Results Control: Collapse All | Expand All

Click on the links below to expand individual categories.

Category: Intersection geometry (3)

Category: Intersection traffic control (64)

- Crash Type
- Crash Severity
- Roadway Type
- Area Type
- Intersection Type
- Intersection Geometry
- Traffic Control
- In HSM

Filter Results

Category: Intersection traffic control (64)

- Countermeasure: Change from permitted or permitted-protected to protected
- Countermeasure: Change from permitted to protected on minor approach
- Countermeasure: Change from permitted-protected to protected on major approach
- Countermeasure: Change from permitted-protected to protected on minor approach
- Countermeasure: Change from protected/permitted to protected only left turn signal control during special time-of-day (left turn crashes)
- Countermeasure: Change left-turn phase from permissive to protected/permissive or permissive/protected phasing on one or more approaches
- Countermeasure: Change left-turn phase to protected phasing on one or more approaches
- Countermeasure: Change permissive left-turn phasing to protected only
- Countermeasure: Change permissive left-turn phasing to protected only or protected/permissive
- Countermeasure: Change permissive left-turn phasing to protected/permissive
- Countermeasure: Change permitted to protected/permitted or permitted/protected
- Countermeasure: Changed permitted to permitted/protected on minor approach
- Countermeasure: Changing left-turn phasing from protected to flashing yellow arrow

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tersection Type
tersection Geometry
affic Control
HSM
ilter Results

▼ Countermeasure: Change from permitted to protected on minor approach

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
0.01	99	★★★★★	Angle	All	Urban	Davis and Aul, 2007	
0.83	18	★	all	All	Urban	Davis and Aul, 2007	

▼ Countermeasure: Change from permitted-protected to protected on major approach

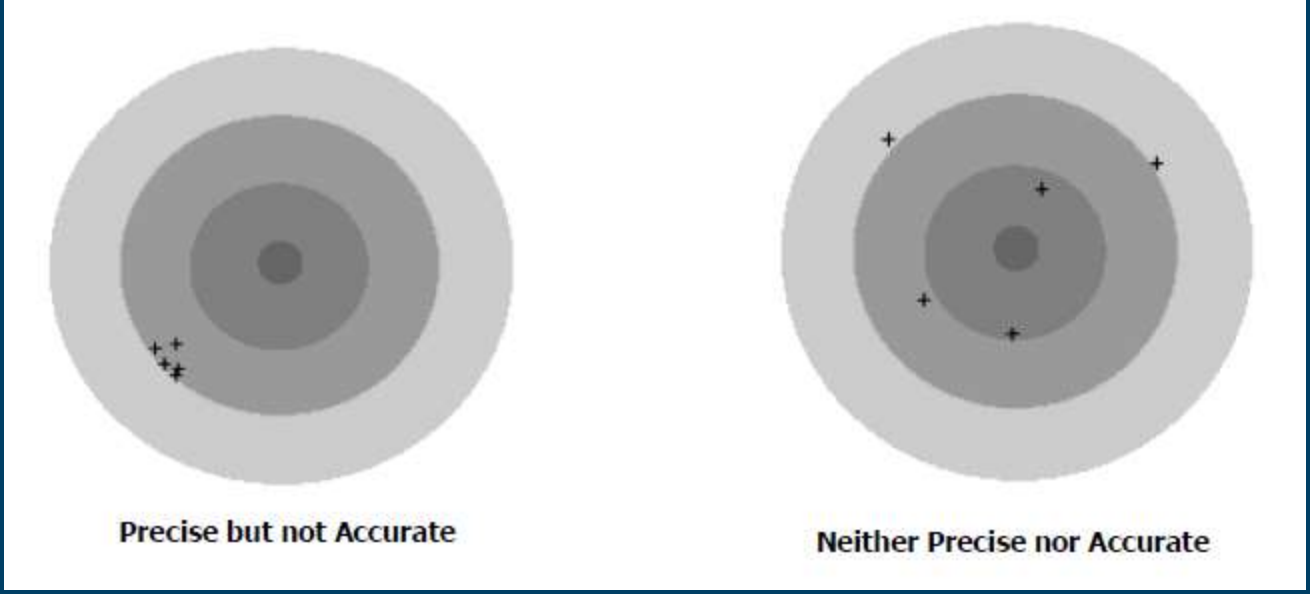
CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
0.01	99	★★★★★	Angle	All	Urban	Davis and Aul, 2007	
0.58	42	★★★	All	All	Urban	Davis and Aul, 2007	

▼ Countermeasure: Change from permitted-protected to protected on minor approach

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
0.04	97	★★★★	Angle	All	Urban	Davis and Aul, 2007	
0.99	1	★	all	All	Urban	Davis and Aul, 2007	

▶ Countermeasure: Change from protected/permitted to protected only left turn signal control during special time-of-day (left turn crashes)

Precision vs Accuracy



Search Results

There were 134 CMFs returned for your search on "**Roundabout**". [modify your search].

Having trouble deciding between similar CMFs? Check out our FAQs.

Overwhelmed by too many results? See our Search Tips.

- Star Quality Rating
  - 1 (5)
  - 2 (17)
  - 3 (47)
  - 4 (61)
  - 5 (4)
- Crash Type
- Crash Severity
- Roadway Type
- Area Type
- Intersection Type

Results Control: Collapse All | Expand All

Click on the links below to expand individual categories.

- Category: Bicyclists (6)
- Category: Intersection geometry (113)
- Category: Intersection traffic control (8)
- Category: Speed management (7)

4 (61)
5 (4)

Crash Type
Crash Severity
Roadway Type
Area Type
Intersection Type
Intersection Geometry
Traffic Control
In HSM

Filter Results

Category: Intersection geometry (113)

- Countermeasure: Change roundabout circulating sight distance from X to Y
- Countermeasure: Change roundabout intersection sight distance from X to Y
- Countermeasure: Conversion of intersection into high-speed roundabout
- Countermeasure: Conversion of intersection into low-speed roundabout
- Countermeasure: Conversion of intersection into multi-lane roundabout
- Countermeasure: Conversion of intersection into single-lane roundabout
- Countermeasure: Conversion of no control/yield intersection into single- or multi-lane roundabout
- Countermeasure: Conversion of signalized intersection into single- or multi-lane roundabout
- Countermeasure: Conversion of stop-controlled intersection into multi-lane roundabout
- Countermeasure: Conversion of stop-controlled intersection into single-lane roundabout
- Countermeasure: Conversion of two-way stop-controlled intersection into single- or multi-lane roundabout
- Countermeasure: Convert all-way, stop-controlled intersection to roundabout

HSM

Iter Results

Countermeasure: Conversion of no control/yield intersection into single- or multi-lane roundabout

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
1.242	-24.18	★★★☆☆	All	All	All	Qin et al., 2013	- Study included three-year before ... [read more]
0	100	★★★☆☆	All	Fatal,Serious injury,Minor injury	All	Qin et al., 2013	- Study included three-year before ... [read more]

Countermeasure: Conversion of signalized intersection into single- or multi-lane roundabout

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
0.81	19	★★★★☆	All	All	Urban and suburban	Gross et al., 2012	Conversion to 2-lane roundabout ... [read more]
0.29	71	★★★★☆	All	Serious injury,Minor injury	Urban and suburban	Gross et al., 2012	Conversion to 2 lane roundabout ... [read more]
0.74	26	★★★★☆	All	All	Urban and suburban	Gross et al., 2012	Conversion to one lane roundabout ... [read more]
0.955	4.54	★★★★☆	All	All	All	Qin et al., 2013	- Study included three-year before ... [read more]
0.65	35	★★★☆☆	All	All	Urban	Persaud et al., 2001	

▼ Countermeasure: Conversion of stop-controlled intersection into single-lane roundabout

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
0.28	72	★★★★☆	All	All	Urban	Persaud et al., 2001	
0.42	58	★★★★☆	All	All	Rural	Persaud et al., 2001	
0.12	88	★★★★☆	All	Serious injury,Minor injury	Urban	Persaud et al., 2001	
0.18	82	★★★★☆	All	Serious injury,Minor injury	Rural	Persaud et al., 2001	

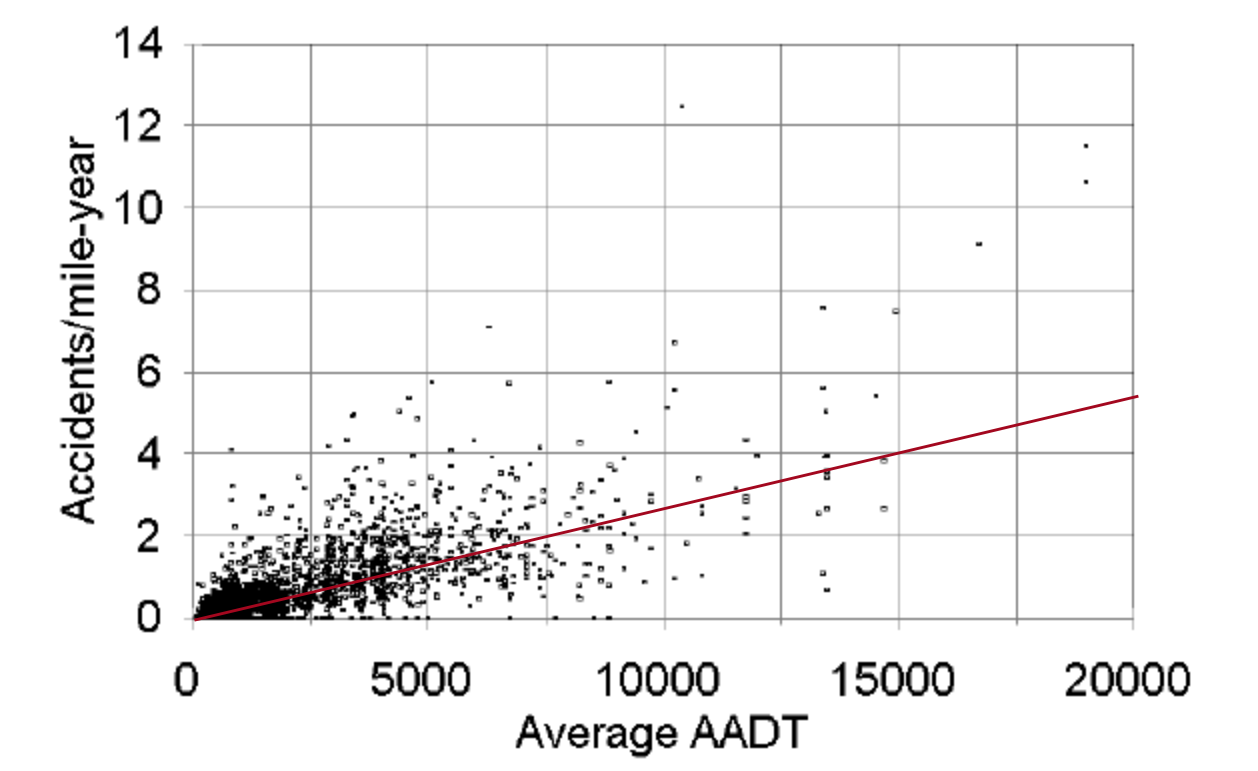
▶ Countermeasure: Conversion of two-way stop-controlled intersection into single- or multi-lane roundabout

▼ Countermeasure: Convert all-way, stop-controlled intersection to roundabout

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
1.114	-11.36	★★★★☆	All	All	All	Qin et al., 2013	- Study included three-year before ... [*read more*]
1.03 [I]	-3	★★★☆☆	All	All	All	Rodegerdts et al., 2007	
0.544	45.6	★★★☆☆	All	Fatal,Serious injury,Minor injury	All	Qin et al., 2013	- Study included three-year before ... [*read more*]

Accuracy & Precision?

Study of Two-Lane Rural Roads in Colorado



Source: Figure 3B-1 and Figure 10-3 HSM

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Example – Enhance delineation

- 2-lane rural roadway, AADT = 16,000
- Nighttime + wet-weather crashes
- County-maintained roadway
- Currently, no RPM's

Example: Add RPMs on 2-lane

- Look up enhanced delineation in Part D of HSM:

Table 13-41. Potential Crash Effects of Installing Snowplowable, Permanent RPMs

Treatment	Setting (Road type)	Traffic Volume AADT	Accident type (Severity)	CMF	Std. Error
Install snowplowable permanent RPMs	Rural (Two-lane with radius > 1640 ft)	0 to 5,000	Nighttime All types (All severities)	**1.16**	**0.03**
		5,001 to 15,000		**0.99***	**0.06**
		15,001 to 20,000		**0.76**	**0.08**
	Rural (Two-lane with radius ≤ 1640 ft)	0 to 5,000		**1.43**	**0.1**
		5,001 to 15,000		**1.26**	**0.1**
		15,001 to 20,000		**1.03***	**0.1**
Base Condition: Absence of raised pavement markers.					

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WARNING!

ALWAYS use caution when looking up or applying CMF's or CRF's

Is this applicable?

- Text in the HSM study clearly says "installation of **snowplowable**, permanent RPM's"
- But isn't every RPM installed in Florida resistant to every snowplow typically used in Florida?
- Proceed with CAUTION!

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Check the notes…

NOTE: **Bold** text is used for the most reliable CMFs. These CMFs have a standard error or 0.1 or less.

* Observed variability suggests that this treatment could result in an increase, decrease or no change in crashes. See Part D Introduction and Applications Guidance.

Example: Add RPMs on 2-lane

Does this make sense?

- Look up enhanced delineation in Part D of HSM:

Table 13-41. Potential Crash Effects of Installing Snowplowable, Permanent RPMs

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		5,001 to 15,000		**0.99***	**0.06**
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	Rural (Two-lane with radius ≤ 1640 ft)	0 to 5,000		**1.43**	**0.1**
		5,001 to 15,000		**1.26**	**0.1**
		15,001 to 20,000		**1.03***	**0.1**
Base Condition: Absence of raised pavement markers.					

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Check the text…

The crash effects of installing snowplowable RPMs on low volume (AADT of 0 to 5,000), medium volume (AADT of 5,001 to 15,000), and high volume (AADT of 15,001 to 20,000) roads are shown in Table 13-411 (2).

The varying crash effect by traffic volume is likely due to the lower design standards (e.g., narrower lanes, narrower shoulders, etc.) associated with low volume roads (2). Providing improved delineation, such as RPMs, may cause drivers to increase their speeds. The varying crash effect by curve radius is likely related to the negative impact of speed increases (2). The base condition of the CMFs (i.e., the condition in which the CMF = 1.00) is the absence RPMs.

Example: Add RPMs on 2-lane

- Look up enhanced delineation in Part D of HSM:

Note which crash types this applies to

Table 13-41. Potential Crash Effects of Installing Snowplowable, Permanent RPMs

Treatment	Setting (Road type)	Traffic Volume AADT	Accident type (Severity)	CMF	Std. Error
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		5,001 to 15,000		**1.26**	**0.1**
		15,001 to 20,000		**1.03***	**0.1**
Base Condition: Absence of raised pavement markers.					

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Example – Enhance delineation

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- County-maintained roadway
- Currently, no RPM's

Example: Add RPMs on 2-lane

- Look up enhanced delineation in Part D of HSM:

Table 13-41. Potential Crash Effects of Installing Snowplowable, Permanent RPMs

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		5,001 to 15,000		**1.26**	**0.1**
		15,001 to 20,000		**1.03***	**0.1**
Base Condition: Absence of raised pavement markers.					

So what do we do?

- CMF = 0.76 => CRF = 0.24
- Nighttime crashes only
- Perhaps use CMF = 80%
- Perform before – after
- Submit your results to the CMF Clearinghouse

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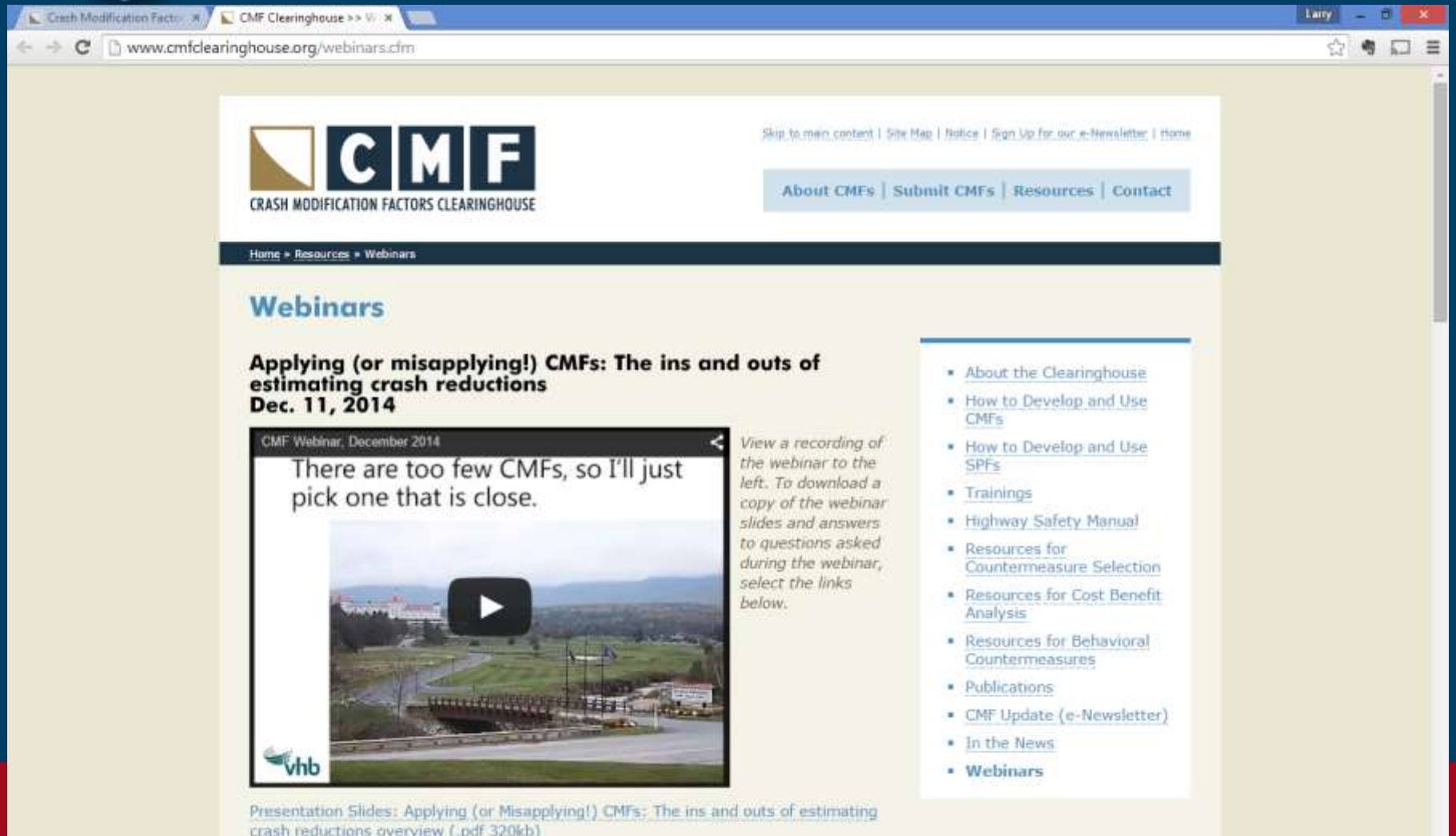
For more information…



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WARNING!

ALWAYS use caution when looking up or applying CMF's or CRF's


That's all Folks!

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Don’t forget your PDH form…

- Email completed form to:

  Larry@HagenConsultingServices.com

- Fax completed form to

  866-426-5153 (toll free)

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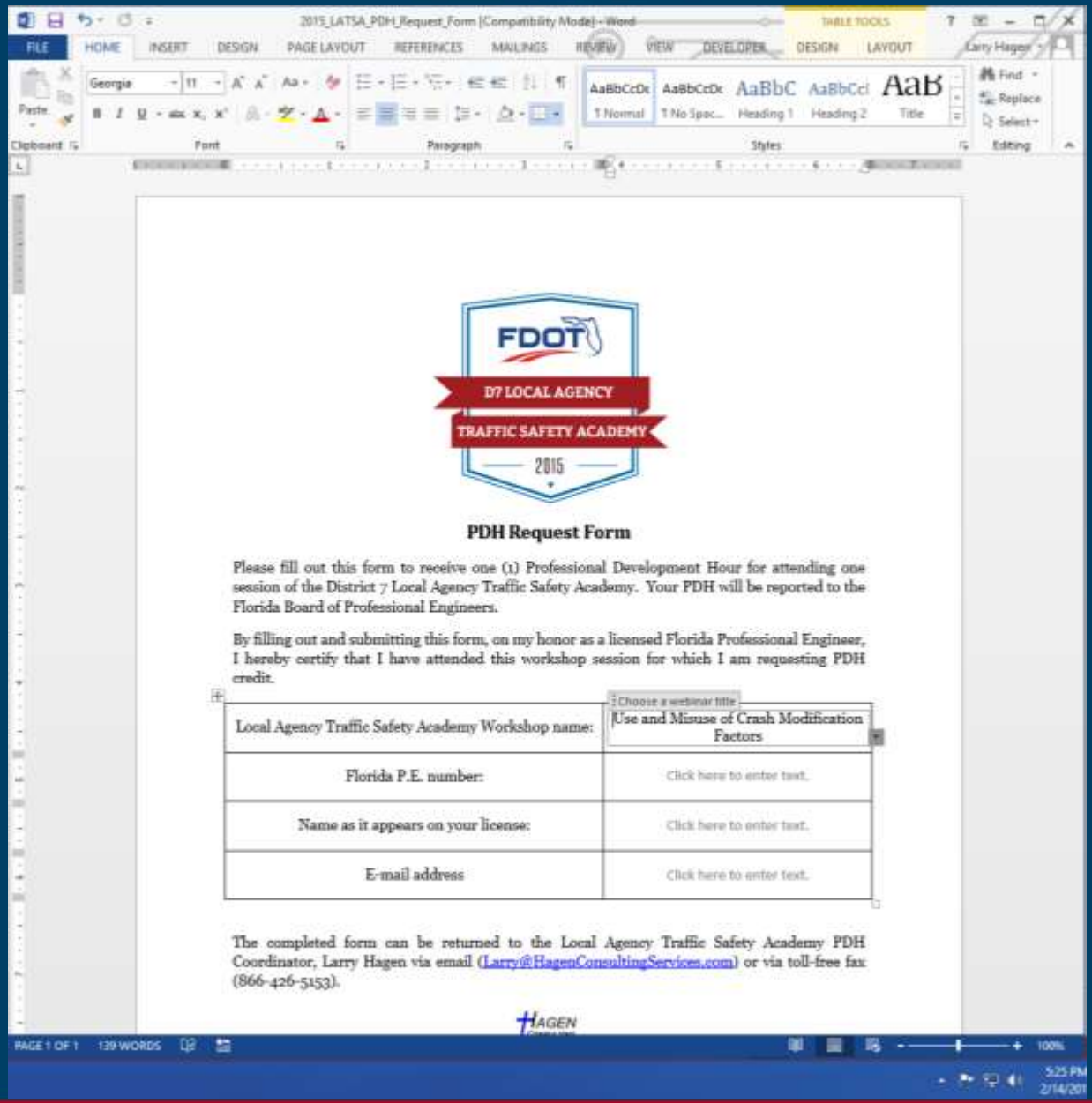

"Driving Down Fatalities Through Knowledge Sharing"

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Use and Misuse of Crash Modification Factors

Fun, fun, fun ‘till your daddy takes the T-bird away

Questions?

Please type your questions into the chat box