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# SAFETY INVESTIGATION MANUAL

## CHAPTER 6: COUNTERMEASURE SELECTION AND RECOMMENDED IMPROVEMENTS ANALYSIS

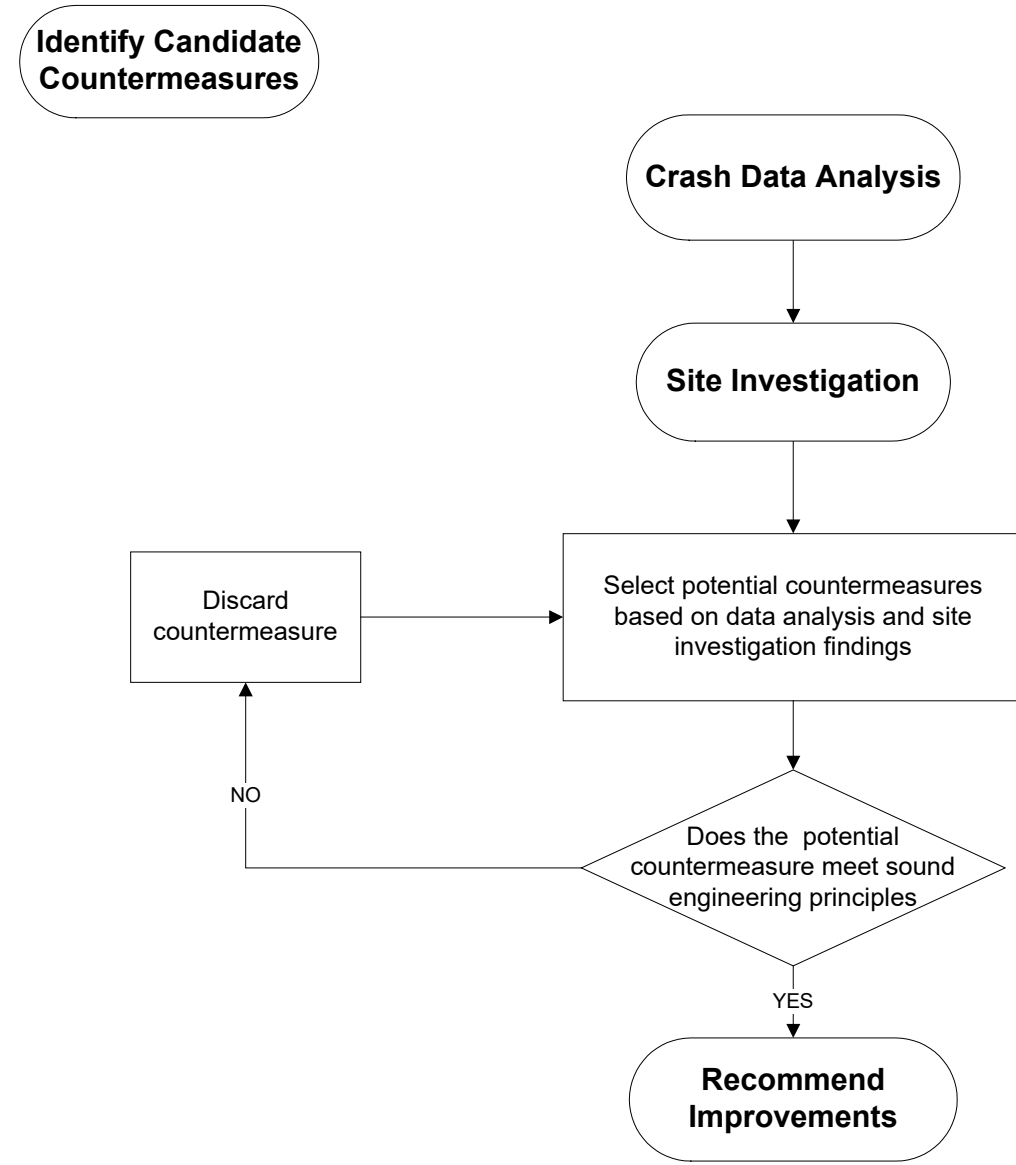
Online Training

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# Countermeasure Selection

- Countermeasure is a modification, improvement, or design intended to reduce crash frequency or severity
- Selection of countermeasures guided by data analysis and site investigation findings
- Is a “fix” to the safety issue
- Two approaches:
  - Countermeasures for overrepresented crash types
  - Strictly considering crash reductions



# Countermeasure Selection

- Several resources to identify potential countermeasures
- Identification of potential countermeasures involves mapping the correctable crash type to a possible countermeasure
- SIM provides crash patterns and probable causes in Table 3, 4, 5, 6 in Chapter 5
- Countermeasures will to evaluated for cost effectiveness and feasibility
- Important to check if recommended solutions have delegated authority processes

**Intersection Safety**

FHWA is committed to the vision of zero deaths and serious injuries on the Nation's roadways. Strategies to address intersection safety are diverse, and quite often a combination of strategies is needed to truly solve a problem. This web page contains information on many intersection safety topics, including intersection safety data, the choice of appropriate intersection designs, and specific intersection safety countermeasures.

**About Intersection Safety**

**Intersection Control Evaluation**

**Safe System Intersections**

**Corridor Access Management**

**Roundabouts**

**Stop-Controlled Intersections**

**Signalized Intersections**

**Crossover Intersections**

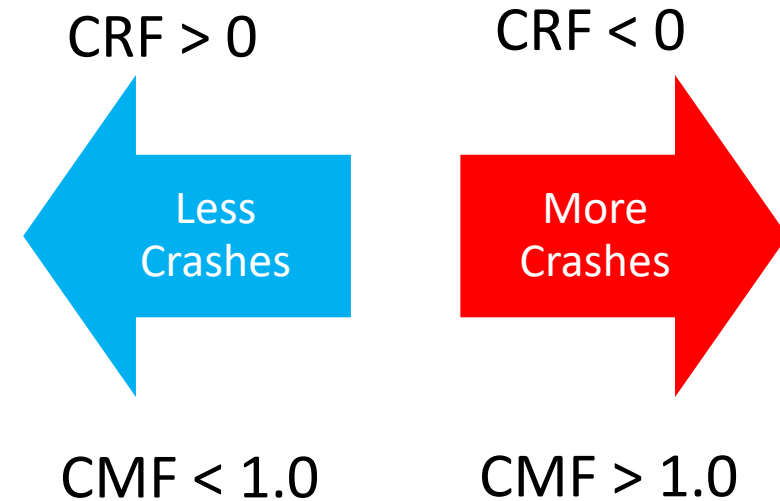
**Reduced Left-Turn Conflict Intersections**

**Other Intersection Designs**

FHWA Safety Emphasis Area websites are useful starting points

# Countermeasure Effectiveness

- Crash Modification Factor (CMF)
  - A multiplicative factor representing the fraction of the total crashes expected after the countermeasure
- Crash reduction factor (CRF)
  - A percent reduction in the “before” crashes after implementing the countermeasure
- A CMF/CRF is relative to a given base condition
  - $CMF < 1$  = less crashes
  - $CMF > 1$  = more crashes
  - Note  $CRF = (1 - CMF)$

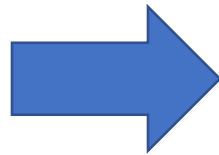


# Base Conditions

- CMF/CRFs are the change from the base condition to the new condition specific to a crash type, severity and roadway context specific.
  - total crashes, run-off-road, night, wet weather, multi-vehicle
  - rural, urban, arterial, freeway



Urban, all-way stop controlled



Urban, 1-lane roundabout

# Key Resources

- ARTS CRF List
  - List of approved countermeasures and their CRF
- FHWA CMF Clearinghouse
  - Searchable by crash type, severity, roadway type and others
  - Uses a star rating system where more stars indicate a more reliable CMF.
  - Star rating based on study type, sample size, and quality of research

Application Type	Countermeasure	Description	Crash Type	Injury, PDO or All	Severity	Existing Intersection Traffic Control	Unknown or Road	CMF	Range of CMF
Highway	W1	Median U-Turn Restraints Treatment	All	All Injury (Excludes PDO's)	20	Signalized or Unsignalized	Urban or Rural	38	15 - 20%
Highway	W2	High Turn Lanes on High-Major Road Approaches (Unsignalized Intersections (2 or 4 Lanes))	All	All	20	Unsignalized	Urban or Rural	16	14 - 20%
Highway	W3	High Turn Lanes on Both Major Road Approaches (Unsignalized Intersections (2 or 4 Lanes))	All	All	20	Unsignalized	Urban or Rural	26	14 - 20%
Highway	W4	High Turn Lanes on High-Major Road Approaches (Signalized Intersections (2 or 4 Lanes))	All	All	20	Signalized	Urban or Rural	4	4 - 9%
Highway	W5	High Turn Lanes on Both Major Road Approaches (Signalized Intersections (2 or 4 Lanes))	All	All	20	Signalized	Urban or Rural	8	4 - 9%
Highway	W6	Classified High Turn Lanes with Raised Median	All	All Injury (Excludes PDO's)	20	Signalized or Unsignalized	Urban or Rural	25	25 - 50%
Highway	W7	Left Turn Lanes on High-Major Road Approaches (Unsignalized Intersections (2 Lanes))	All	All	20	Unsignalized	Urban	23	20 - 50%
Highway	W8	Left Turn Lanes on Both Major Road Approaches (Urban, Unsignalized Intersections (2 Lanes))	All	All	20	Unsignalized	Urban	47	41 - 50%
Highway	W9	Left Turn Lanes on High-Major Road Approaches (Rural, Unsignalized Intersections (2 Lanes))	All	All	20	Unsignalized	Rural	44	20 - 50%
Highway	W10	Left Turn Lanes on Both Major Road Approaches (Rural, Unsignalized Intersections (2 Lanes))	All	All	20	Unsignalized	Rural	48	41 - 50%
Highway	W11	Left Turn Lanes on High-Major Road Approaches (Urban, Signalized Intersections (2 Lanes))	All	All	20	Signalized	Urban	7	1 - 5%

**CMF CLEARINGHOUSE**  
CRASH MODIFICATION FACTORS CLEARINGHOUSE

Home > Advanced Search Results

### Advanced Search Results

There were 56 results returned for this search. [Modify Search](#)

**Category: Intersection geometry**

Countermeasure: Add left-turn lanes to major road approaches at intersections

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type	Reference
0.42	58	★★★★★	All	Fatal, Serious Injury, Minor Injury	Not specified	Rural	Harwood et al., 2002

Countermeasure: Addition of left- or right-turn by-pass lanes

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type	Reference
0.95	5	★★★★	All	All	Not specified	Rural	Preston and Schoenfelder, 1999
0.81	19	★★★★	All	Property damage only (PDO)	Not specified	Rural	Preston and Schoenfelder, 1999
1.25	-25	★★★★	All	Fatal, Serious Injury, Minor Injury	Not specified	Rural	Preston and Schoenfelder, 1999

Countermeasure: Closure or complete relocation of all driveways from functional area of intersection

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type	Reference
1.17	-17	★★★★	All	All	Principal Arterial Other	Rural	Lall et al., 1995
1.41	-41	★★★★	All	Serious Injury, Minor Injury	Principal Arterial Other	Rural	Lall et al., 1995

# Example Problem

A location has 14 crashes per year.

Two countermeasures have been selected with a CRF1 = 10%, CRF2 = 30% (or CMF1 = 0.90 and CMF2 = 0.70)

- A. How many crashes were reduced?
- B. How many crashes will occur per year after the countermeasure?

## With CRF

First, calculate the composite CRF =  $0.1 + (1 - 0.1)(0.3) = 0.37$  or 37%

*[Note: 0.1 is 10% in decimal form and 0.3 is 30% in decimal form.]*

- A. crashes reduced =  $14[0.37] = 5.18$  crashes
- B. crashes expected after countermeasure = total – reduced =  $14 - 5.18 = 8.82$  crashes

## With CMF

CMF = 0.90, CMF = 0.70, with CMF b) is easier to answer first

- B. crashes expected after countermeasure =  $(14 \text{ crashes})(0.9)(0.7) = 8.82$  crashes
- A. crashes reduced = total – expected after =  $14 - 8.82 = 5.18$  crashes

# Recommended Improvements

- Countermeasures must be economically feasible
  - Benefits considered as savings in crashes over the life of the project
  - Costs include initial capital investment
- ARTS program has benefit-cost and cost-effectiveness worksheets available.
- Final recommended countermeasures are identified by crash data analysis, field investigation, and were determined cost effective.



Example of a recommended and implemented countermeasure