



**Alaska Department of
Transportation & Public Facilities**
**Calibration of the Highway Safety Manual for Cold
Regions**
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October 28th, 2016



Local Calibration, HSM

- What is the HSM?
- Purpose and Need
- Methodology
- Crash and Intersection Data
- Results
- Recommendations

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Calibration of the Highway Safety Manual for Cold Regions

This project is funded by:

- Alaska Department of Transportation & Public Facilities (AKDOT&PF)
- Federal Highway Administration (FHWA)


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What is the HSM?

- First published by AASHTO in 2010
- Presents methods to quantitatively analyze safety at a given site or site type
- Presents methods to estimate crash frequency and severity
- Results integrated into future projects to increase safety of roadways in a cost-effective manner

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Current Progress for HSM

- Member of National Cooperative Highway Research Program Project Panel 17 -68., “Intersection Crash Prediction Methods for the Highway Safety Manual.” Washington D.C., FY 2014-17

| Intersection type | HSM Chapter | | | | |
|---|-------------|----|----|--------|------------------|
| | 10 | 11 | 12 | Ramps* | No current model |
| Three-leg intersections with stop control on minor approach | X | X | X | | |
| Four-leg intersections with stop control on minor approaches | X | X | X | | |
| Three-leg intersections with signal control | | | X | | |
| Four-leg intersections with signal control | X | X | X | | |
| Intersections with no control (typically very low traffic volumes) | | | | | X |
| Intersections with yield control on minor approaches | | | | | X |
| Intersections with all-way stop control | | | | | X |
| Three-leg intersections with a commercial driveway forming a fourth leg | | | | | X |
| Intersections on high-speed expressways | | | | | X |
| Five-leg intersections | | | | | X |
| Six-or-more-leg intersections | | | | | X |
| Diamond ramp terminals at crossroad | | | | X | |
| Parclo ramp terminals at crossroad | | | | X | |
| Free-flow ramp terminals at crossroad | | | | X | |
| Single-point diamond ramp terminal at crossroad ^b | | | | | X |
| Diverging-diamond ramp terminals at crossroad | | | | | X |


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Current Progress for HSM

- Member of National Cooperative Highway Research Program Project Panel 17 -74., “Developing Crash Modification Factors for Corridor Access Management “ Washington D.C., FY 2015-18


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Purpose and Need

- Why is a Calibration Factor needed?
 - Used to determine average predicted crash rates along sections of roadways/intersections
 - Method derived from Highway Safety Manual (HSM) which is based on lower 48 calibration data sets
 - Used to determine if cold region calibration factor(s) are significantly different than lower 48 calibration factor values and if necessary as a design criteria


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Site Types Calibrated


- Three- and Four-leg Stop-Controlled Intersections
- Four-leg Signalized Intersections
- Rural Two-lane Two-Way Highway Segments

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Regional Breakdown

- Central
 - Includes Anchorage Bowl
- Northern
 - Includes Fairbanks
- Southcoast
 - Includes Ketchikan, Sitka, Juneau




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Regional Differences

- Potential Regional Differences:
 - Weather/Climate
 - AADT
 - Driver Behavior
 - Congestion
 - Wildlife
 - Daylight Hours
 - Crash Rates

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Methodology

- Acquire a list of sites to be calibrated
- Randomly sample sites until the appropriate sample size is reached (at least 100 crashes per intersection per year and at least 30 sites)
- Collect geometric information needed for Safety Performance Functions (SPFs)
 - In this study, this data was collected using Google Earth, Google Maps, site visits, MOA's map of AADT values, or was provided by the AKDOT&PF
- Apply HSM-given SPFs to find predicted crashes
- Apply the equation:

$$C = \frac{\sum \text{all sites}_{\text{observed crashes}}}{\sum \text{all sites}_{\text{predicted crashes}}}$$


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Methodology

In some cases, the methodology used differed for the different facility types calibrated, or deviated from the HSM. These deviations are discussed next.


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Stop-Controlled Intersections Methodology Changes

- Calibration factors found for each facility type individually per region
- Some may be combined
- Validation possible for Central Urban intersections


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Two-Lane Highway Segments Methodology Changes

- No uniform segments met HSM requirements
 - Took many smaller segments and combined them into one larger segment that satisfied the HSM's requirements

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Data Characteristics of Available Data

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Stop Control Intersections

All Regions

Definitions

U 3ST/4ST : Urban and Suburban Arterial 3-leg/4-leg Stop-Controlled Intersections

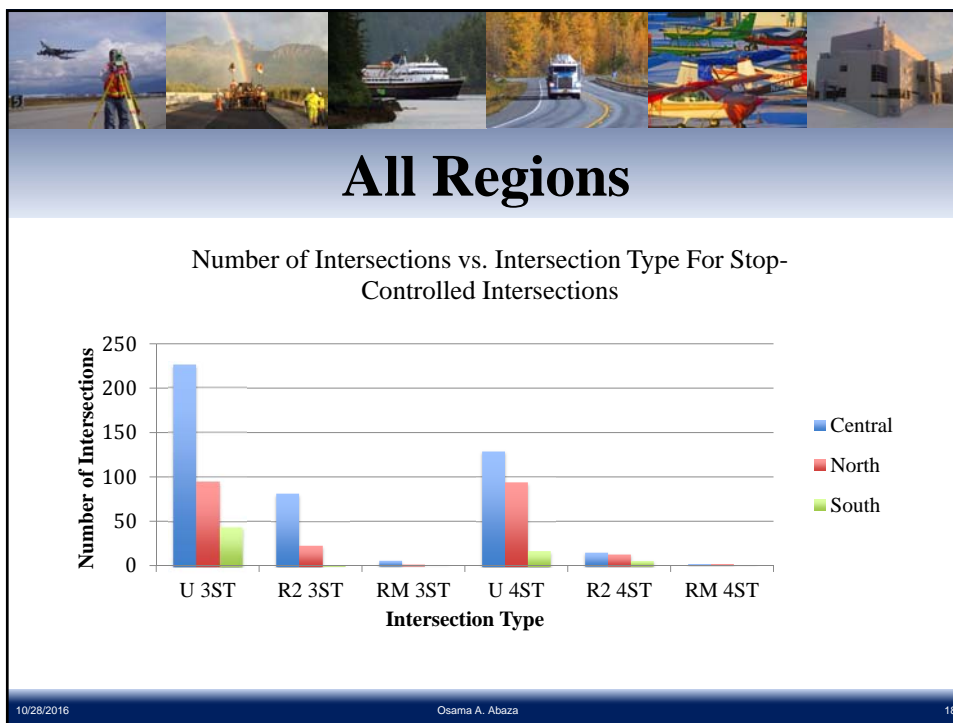
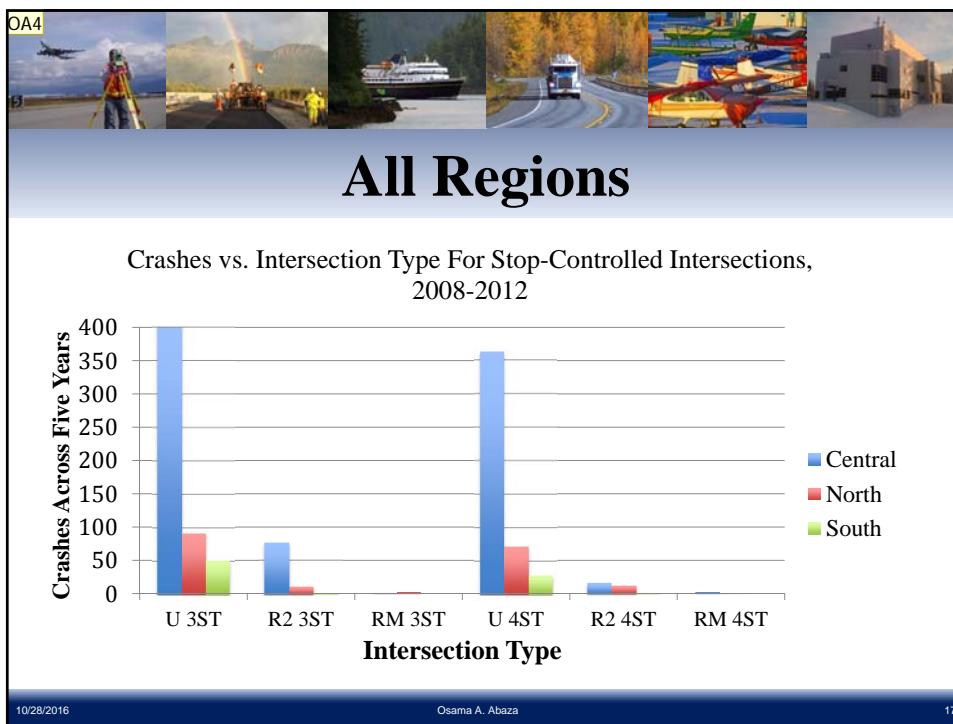
R2 3ST/4ST : Rural Two-Lane 3-leg/4-leg Stop- Controlled Intersections

RM 3ST/4ST: Rural Multilane 3-leg/4-leg Stop- Controlled Intersection

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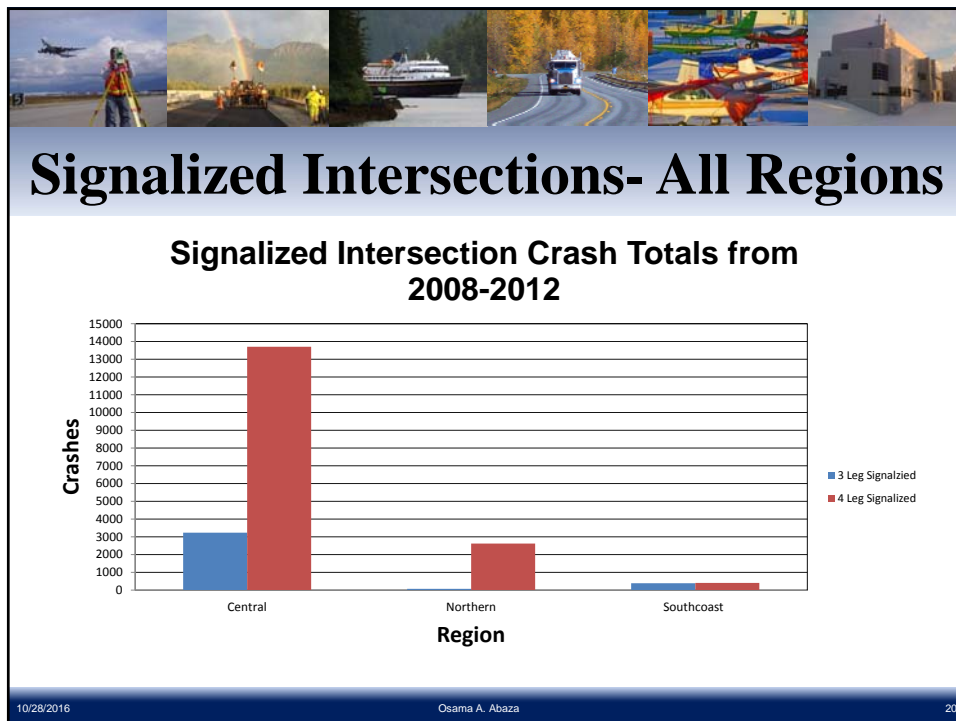
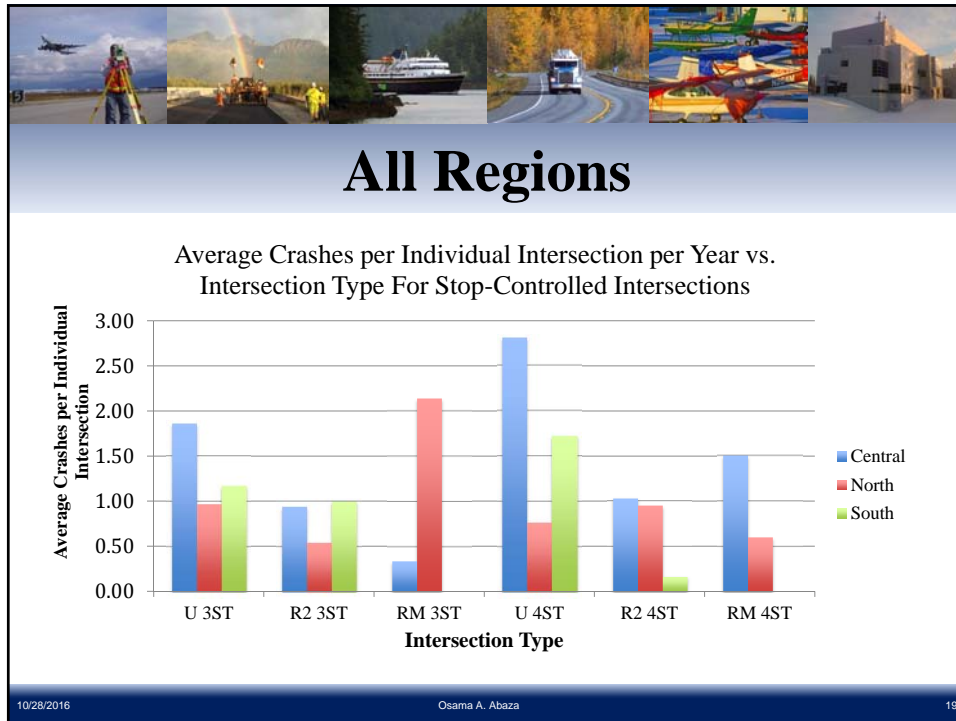
Slide 16

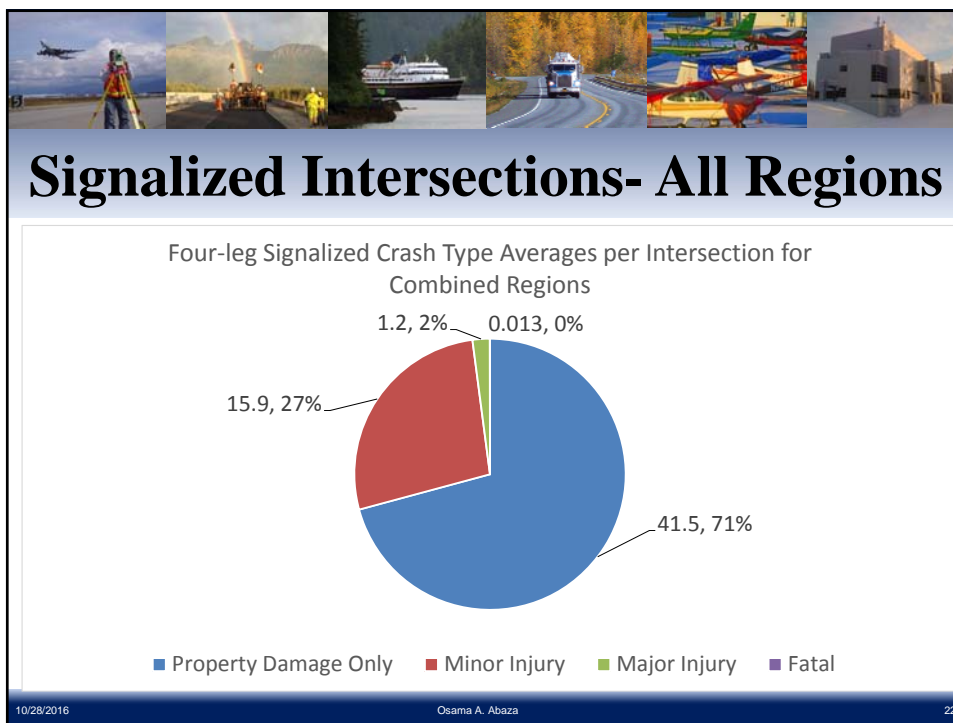
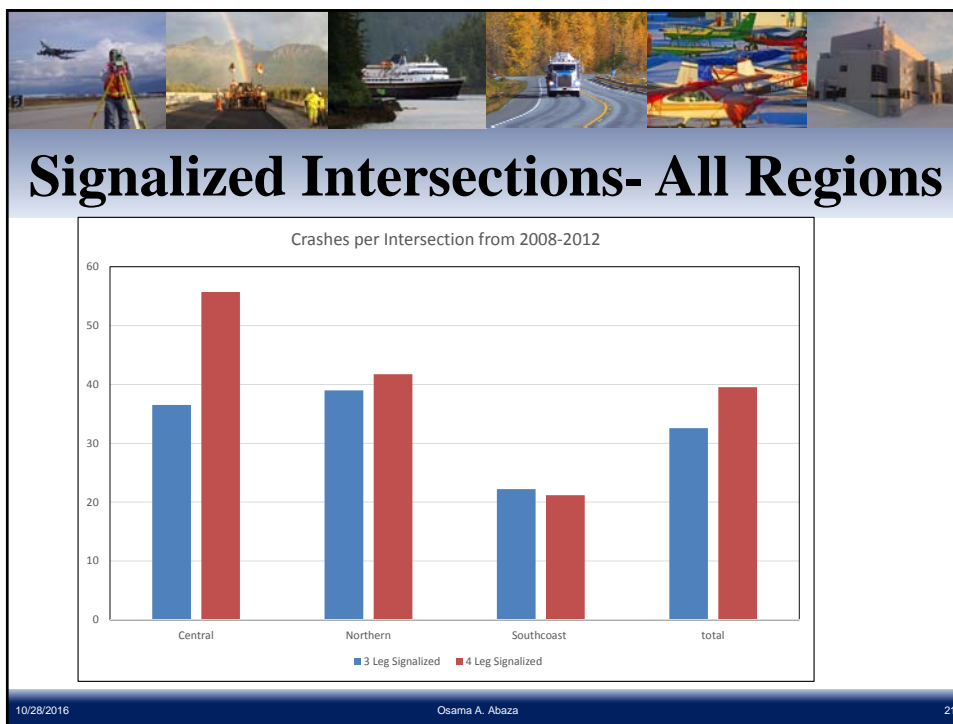
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Osama Abaza, 10/17/2016




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Two-Lane Highway Segments All Regions

Crash Rates on Two-Lane Highway Segments


| Classification | Length of roadway (mi) | Total crashes (2008-2012) | Crashes per mile per year |
|----------------|------------------------|---------------------------|---------------------------|
| Interstate | 982 | 2905 | 0.59 |
| Major Arterial | 790 | 1796 | 0.45 |
| Minor Arterial | 417 | 591 | 0.28 |
| Total | 2189 | 5292 | 0.49 |

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Data Analysis and Calibration Results

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Stop-Controlled Intersections Data Analysis

Rural Two-Lane 3-Leg Stop-Controlled Intersection Data Sample

| Major Street | Minor Street | Predicted Crashes | Observed Crashes |
|----------------------|-------------------------------|-------------------|------------------|
| BADGER LOOP RD | NORDALE RD | 7 | 10 |
| CHENA HOT SPRINGS RD | NORDALE RD | 4 | 5 |
| RICHARDSON HIGHWAY | JACK WARREN ROAD * DELTA JCT | 5 | 3 |
| RICHARDSON HIGHWAY | JOHNSON ROAD * SALCHA | 3 | 2 |
| PARKS HIGHWAY | LESTER ROAD * HEALY | 2 | 1 |
| RICHARDSON HIGHWAY | DENALI HIGHWAY | 1 | 0 |
| MURPHY DOME ROAD | SPINACH CREEK ROAD (S OF FOX) | 2 | 0 |
| PARKS HIGHWAY | SUNTRANA ROAD * HEALY | 2 | 0 |
| PARKS HIGHWAY | PARK LANE * HEALY | 1 | 0 |


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Stop-Controlled Intersections Calibration Results- **Northern Region**

- Urban 3ST
 - CF = 1.33
- Urban 4ST
 - CF = 0.99
- Rural Two-Lane 3ST
 - CF = 1.11
- Rural Two-Lane 4ST
 - CF = 0.93
- Multilane intersections not calibrated due to lack of information


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Stop-Controlled Intersections Calibration Results- Central Region

- Urban 3ST
 - CF = 1.72
- Urban 4ST
 - CF = 2.37
- Rural Two-Lane 3ST
 - CF = 0.82
- Rural Two-Lane 4ST
 - CF = 0.80
- Multilane intersections not calibrated due to lack of information


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Stop-Controlled Intersections Calibration Results- Southcoast Region

- Urban 3ST
 - CF = 1.60
- Urban 4ST
 - CF = 1.04
- All rural intersections were not calibrated due to a lack of information


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Stop-Controlled Intersections Validation

- Intersections not used for original calibration were then combined and another validation CF values found from these intersections
- Urban 3ST
 - Validation CF value = 1.85
- Urban 4ST
 - Validation CF value = 1.83
- Suggests higher CF values are indeed valid

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Signalized Intersections Data Analysis

Four-Leg Signalized Data Sample

| Major Street | Minor Street | Predicted Crashes | Observed Crashes |
|-------------------|--------------------------|-------------------|------------------|
| 100TH AVENUE | KING STREET | 2 | 7 |
| 15TH AVENUE | LAKE OTIS PARKWAY | 9 | 134 |
| MINNESOTA DRIVE | 26TH AVENUE | 26 | 28 |
| H STREET | 4TH AVENUE | 7 | 25 |
| 5TH AVENUE | CONCRETE STREET | 28 | 61 |
| 5TH AVENUE | AIRPORT HEIGHTS DRIVE | 37 | 226 |
| MULDOON ROAD | 6TH AVENUE | 21 | 88 |
| 88TH AVENUE | TOLOFF STREET | 10 | 10 |
| INTL AIRPORT ROAD | ARCTIC BLVD | 25 | 101 |
| TUDOR ROAD | BAXTER ROAD/BEAVER PLACE | 25 | 52 |
| O'MALLEY ROAD | BIRCH ROAD | 7 | 11 |
| BONIFACE PARKWAY | NORTHERN LIGHTS BLVD | 34 | 180 |
| TUDOR ROAD | BONIFACE PARKWAY | 26 | 109 |
| MULDOON ROAD | BOUNDARY AVENUE | 26 | 88 |
| C STREET | POTTER DRIVE | 18 | 61 |
| C STREET | RASPBERRY ROAD | 18 | 43 |
| C STREET | 100TH AVENUE | 4 | 13 |


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Signalized Intersections Results

- Four-leg Signalized Intersection Calibration Factors:
 - Central: 3.66
 - Northern: 3.29
 - Southcoast: 1.84

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Signalized Intersections Validation

- Central Region Validation Set of 46 Intersections Taken:

| t-Test: Paired Two Sample for Means | | |
|-------------------------------------|-------------|-----------------------------------|
| | N predicted | N observed |
| Mean | 68.81 | 56.67 |
| Variance | 1260.67 | 2405.09 |
| Observations | 45 | 45 |
| Pearson Correlation | 0.67010693 | |
| df | 44 | |
| t Stat | 2.232 | |
| P(T<=t) two-tail | 0.031 | < .05 so significant |
| t Critical two-tail | 2.015 | < t stat so significant |


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Two-Lane Highway Segments Calibration Results

- Central Region
 - $CF = 1.25$
- Northern Region
 - $CF = 1.22$
- Combined
 - $CF = 1.25$


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Conclusions

- Recommend developing Alaska-specific SPFs
- Some regional differences are estimated to affect Calibration Factor results more than others
 - These include Average Annual Daily Traffic (AADT) and aggressive driving
- Minor regional differences that affect calibration results include:
 - Wildlife, weather, daylight hours

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Recommendations

- For design use only, non enforcement
- Reference for analysis
- Update Calibration Factors every 4-6 years per the HSM
- New data set to use would be 2013-2017 crash data to compare different years


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Stop-Controlled Intersections Recommendations

| Region | Facility Type | Recommended CF Value |
|------------|--------------------------------------|----------------------|
| Northern | Urban & Rural Two-Lane Intersections | 1.10 |
| Central | Rural Two-Lane Intersections | 0.81 |
| | Urban 3-Leg | 1.72 |
| | Urban 4-Leg | 2.37 |
| Southcoast | Urban 3-Leg | 1.60 |
| | Urban 4-Leg | 1.04 |


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Signalized Intersections Recommendations

| Region | Recommended CF Value |
|------------|----------------------|
| Central | 3.66 |
| Northern | 3.29 |
| Southcoast | 1.84 |


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Two-Lane Highway Segments Recommendations

- Recommended to use a CF value of 1.25 for all two-lane rural highway segments in all of Alaska


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Thank you for joining us today

Questions?

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