2025 Alabama Road Safety Conference

AI's Lens: Distracted Driving, Seatbelt Use, and Speeding on Alabama Highways

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Presentation Outline

1. Brief Background

2. Project Goals & Objectives

3. Project Scope

4. Data Collection Setup

5. Presentation of Results

6. Concluding Remarks

Brief Background -
Distracted Driving

According to NHTSA, in 2023:

- **Impact on Fatalities**
  - 3,275 lives lost
  - Contributed to ~8% of total U.S. fatalities.

- **Injury & Crash Involvement**
  - 324,819 people injured.
  - Contributed to ~13% of all injury-related crashes

- **Non-Occupant Fatalities**
  - 611 pedestrians, pedal cyclists, and others killed in distraction-affected crashes.

Brief Background-
Seatbelt Non-compliance

- **According to NHTSA, in 2023**
  - On average, every 50 mins a passenger vehicle occupant not wearing a seat belt dies in a traffic crash.

  - 10,484 passenger vehicle occupants killed in traffic crashes were not wearing seat belts

  - U.S. seat belt use ranged from 68.2 percent to 98.4 percent. A national average of 91.9%
    - Data based on human observers

Brief Background-
Speeding

- **According to NHTSA**
  - For more than two decades, speeding contributes to approximately one-third of all motor vehicle fatalities.

  - In 2023, speeding was a contributing factor in 29% of all traffic fatalities.

Brief Background-
CMV Specific Issues

According to FMCSA - Three of the top 20 CMV driver violations:

- Failure to use seat belt while operating a CMV
  - 50,297 violations reported.

- Using a hand-held mobile telephone
  - 17,861 violations reported.

- CMV speeding (up to 15 mph over posted limit)
  - contributed to approximately 12% of the total 932,495 commercial vehicle violations reported in 2021.

Brief Background-
Traditional vs. AI-Based Detection Methods

Feature	Traditional Methods	AI-Powered Computer Vision
Accuracy	Subject to human error, visibility issues, and sampling bias[1]	Potential for high precision, e.g., ~ 96% for seatbelt violations[1]
Scalability	Low, labor-intensive, restricted geographic coverage	High, automated, cost-effective for large-scale deployment
Vulnerability	High sensitivity to lighting, tinted windows, obstructions[2]	Potential to adapt to varying lighting, and weather conditions[1]

[1] A Comprehensive Analysis of Real-Time Car Safety Belt Detection Using the YOLOv7 Algorithm - MDPI, accessed on June 5, 2025, https://www.mdpi.com/1999-4893/16/9/400

[2] UAV-Based Automatic System for Seatbelt Compliance Detection at Stop-Controlled Intersections - Preprints.org, accessed on June 5, 2025, https://www.preprints.org/manuscript/202503.0114

PROJECT

GOALS, OBJECTIVES, & SCOPE

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Project Goal

- Focus on two FMCSA HP-Grant Priorities
    1. Public awareness & education
    2. Using technologies to improve CMV safety through enforcement

- The overarching goal is to help ALEA / MCSU:
    - Achieve or exceed the CMV fatal crash reduction target of 3% annually
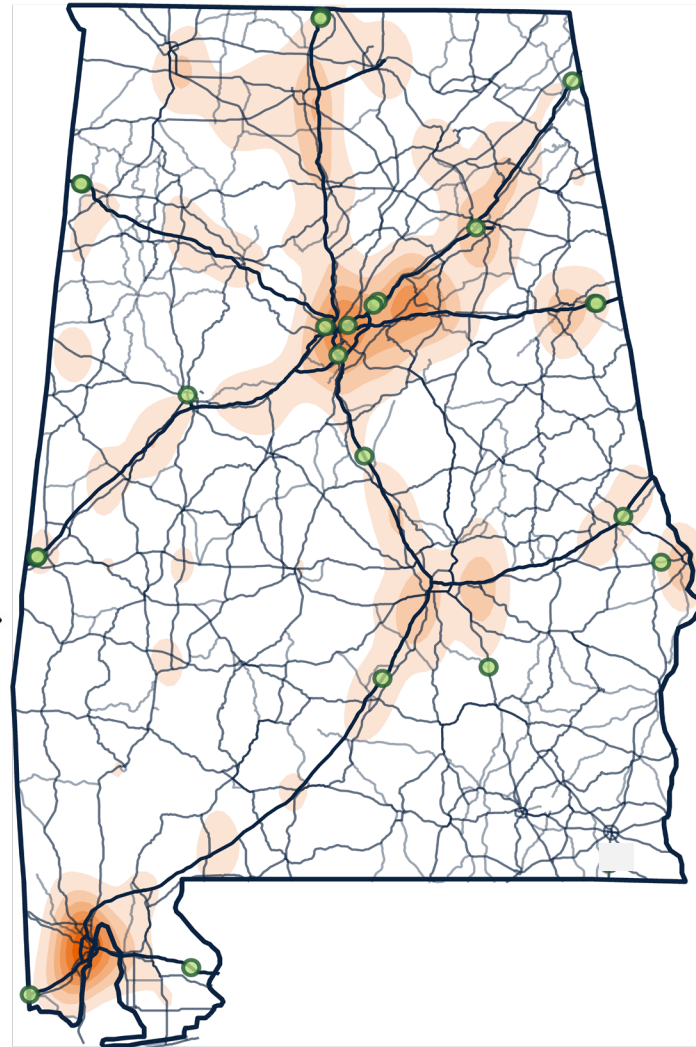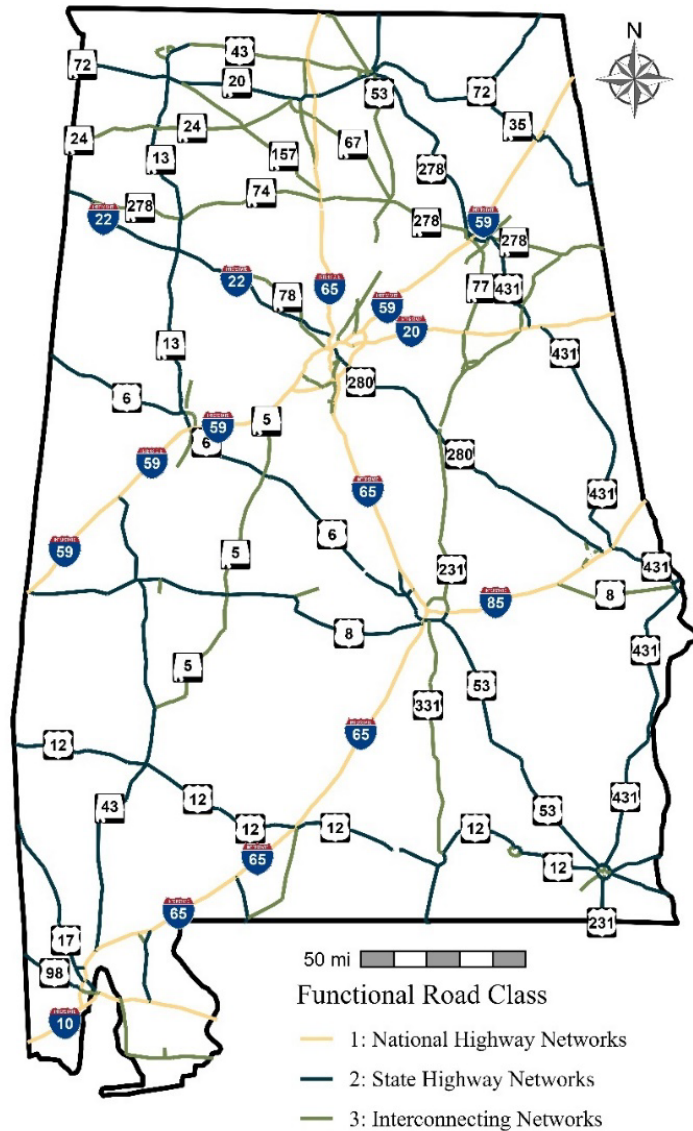   - Reduce the overall AL crashes and severity

Project Objectives

- Deploy an AI system on Alabama roadways to automatically detect:
    - Distracted driving
    - Drivers without seatbelts
    - Vehicle speeds

- Evaluate the accuracy and efficacy of the AI system.
    - Using on-field methods and statistical analysis

- Report on the:
    - Level of distracted driving conditions
    - Seatbelt non-compliance rate
    - Speeding

Scope

- Data collection locations
    - Select 25 sites on U.S. Highways & Interstates in AL
    - Control test site – NCAT test track

- Posted speed limits
    - Ranges from 45 mph to 70 mph.

- Vehicle Detection
    - Twenty (20) of these deployments targeted CMVs

- Driving Conditions
    - Good, snowy, and rainy conditions
    - Work zones

Sites Selected

Number of CMV-Related Fatal Crashes (2018-20...)

- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350

Study Site Locations

○ Study Sites

Functional Road Class

— 1: National Highway Networks
— 2: State Highway Networks
— 3: Interconnecting Networks

50 mi

DATA COLLECTION SETUP & PROTOCOLS

Public Awareness
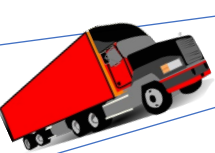

DISTRACTED DRIVING STUDY
LOCAL COVERAGE YOU CAN COUNT ON

Data Collection Setup

1. On Field

AUTRI Data Collection System (Hourly Counts, Classification, Speed)
Purpose: To compare AI capture rates per different conditions

2. Audit Function

- AUTRI has access to the raw data
- AUTRI audit part of the AI output
- Acusensus Human Reviewer audit the same AI output
- Audit report compares AUTRI & Acusensus reviews for consistency
- Output the AI referral rates
  - Distracted
 - Seatbelt

3. Data Storage

- AUTRI has access to the raw data via AWS S3 Console
- Each incident data has four images
  - Number plate
  - Cabin
  - Side
  - Full view
- Each incident data attributes:
  - Site code (AU00..)
  - AI trailer no.
  - Direction of travel
  - GPS Location
  - Lane
  - Offense type
  - Date & Time

AI Identification & Offense Protocol

	CLEAR PHONE scenario
1	Phone held in hand (or both hands) at any height
2	Phone on lap – driver holding phone in hand
3	Phone on lap – driver touching screen of the phone
4	Phone on lap – driver touching fold-over phone case
5	Phone resting on lap or body, even when the phone is not in use
6	Phone on item on driver's body
7	Phone to ear but not held by hand
8	Phone balanced on shoulder, supported by head, not touched by hand
9	Phone balanced on arm, not touched by hand
10	Phone in pouch strapped to arm and touched by hand
11	Phone in pouch strapped to arm, but screen is visible to driver
12	Phone in a pocket or a pouch worn by the driver, screen is visible to driver
13	Phone strapped to seat belt (and touching driver's body)
14	Driver passing phone to passenger

AI Identification & Offense Protocol
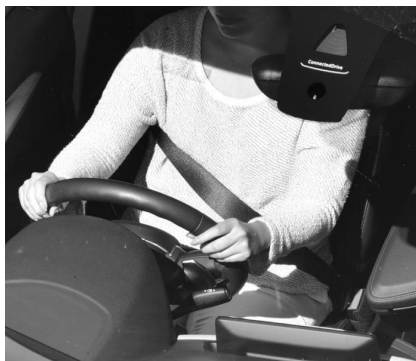
PRESENTATION OF RESULTS

Limitations:

1. The data used for the analysis is exclusively what the AI model captured.

2. Offense rates are analyzed based on images that were captured by the model and confirmed by human reviewers.

Data Classification

Speed Limit	CMV Detections	Non - CMV Detections
45	5,227	
50	2,151	
55	12,990	95,878
60	9,134	
65	7,513	
70	282,006	244,185
Total	319,021 (17%)	340,063 (67%)

CMVs

CMV Detections by Site and Lane

Non-CMVs

Non-CMV Detections by Site and Lane
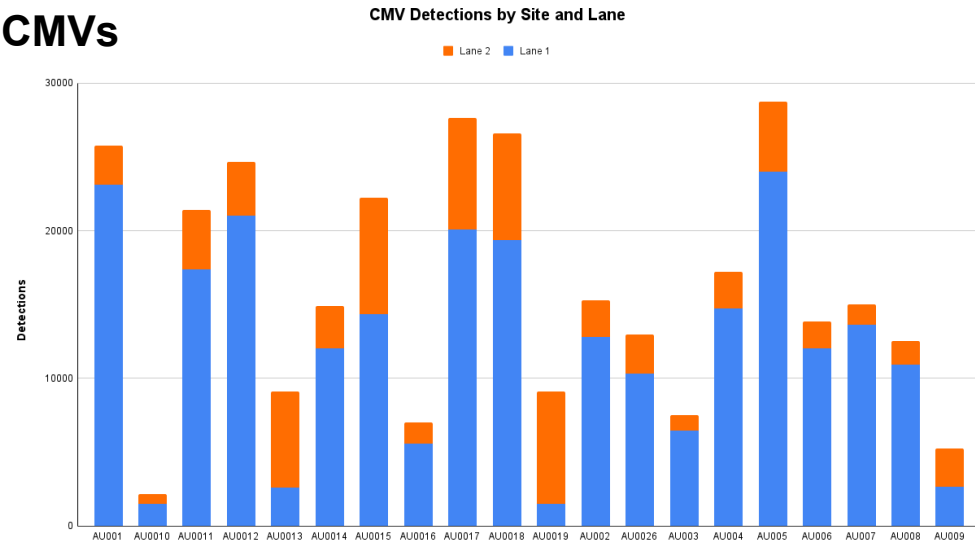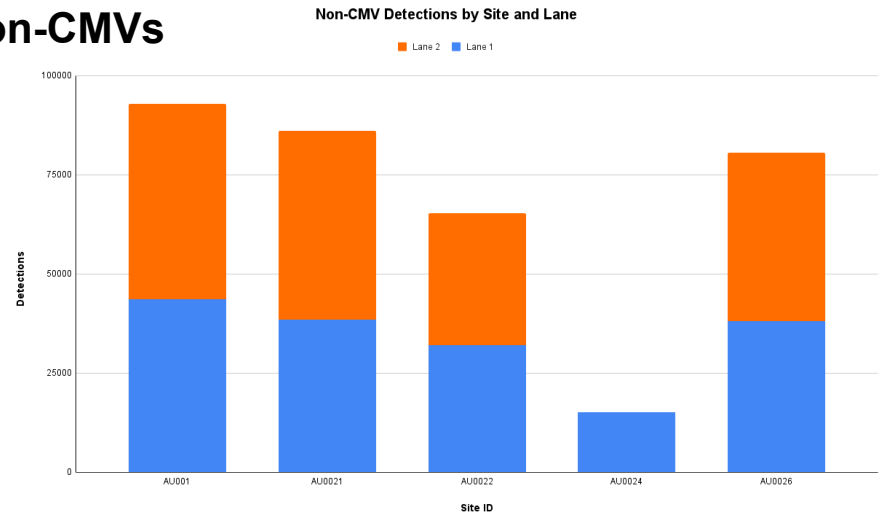
Data Classification – DOW & TOD

CMVs

Hour	Day of the Week							Grand Total
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
00	532	737	1084	1054	1145	1439	1089	7080
01	482	736	1027	1027	1180	1265	1029	6746
02	439	863	1030	1014	1153	1227	1062	6788
03	490	1029	1243	1213	1246	1560	1154	7935
04	530	1225	1418	1455	1649	1769	1253	9299
05	642	1454	1640	1681	2038	2103	1320	10878
06	819	1797	2085	2010	2232	2369	1428	12740
07	1030	2150	2411	2058	2653	2673	1719	14694
08	1272	2446	2368	2371	2973	3045	1978	16453
09	1620	2510	2302	2555	3610	2998	2023	17618
10	1710	2603	2562	2823	3860	3089	2177	18824
11	1700	2568	2849	2633	3776	3370	2164	19060
12	1713	2727	2747	2606	3270	3289	2072	18424
13	1686	2963	2864	2476	3693	3269	1943	18894
14	1843	2803	2671	2810	3575	2797	1761	18260
15	1817	2681	2602	2691	3296	2614	1754	17455
16	1569	2594	2603	2320	3101	2798	1651	16636
17	1554	2345	2253	2329	3127	2675	1575	
18	1459	1900	2042	2500	2714	2343	1347	
19	1297	1694	1856	2041	2550	2098	1127	
20	1139	1565	1434	1768	2201	1959	1034	
21	988	1406	1518	1587	2014	1685	925	
22	928	1183	1276	1511	1689	1705	813	
23	832	1226	1109	1384	1536	1334	662	
Grand Total	28091	45205	46994	47917	60281	55473	35060	

Non-CMVs

Hour	Day of the Week							Grand Total
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
00	664	478	253	290	325	415	656	3081
01	370	307	230	244	294	330	436	2211
02	311	345	220	231	259	306	314	1986
03	254	537	383	437	463	522	363	2959
04	275	1027	860	809	773	835	510	5089
05	361	1692	1247	1426	1306	1198	730	7960
06	321	2061	1596	1780	1783	1644	1223	10408
07	518	2681	1956	2286	2376	2395	1917	14129
08	811	2598	1996	2206	2238	2539	2865	15253
09	1997	2593	2039	2171	2403	1975	3511	16689
10	2540	2725	2244	1963	2649	2448	3620	18189
11	3129	3353	2320	1920	2951	3352	3649	20674
12	3471	3642	2596	2019	3439	4261	4245	23673
13	3795	3982	2706	2304	3815	4154	4263	25019
14	3372	3776	2900	2760	4298	4553	4230	25889
15	3011	2968	3367	4258	4697	5003	4294	27598
16	3085	2982	3379	4727	4894	4841	3809	27717
17	2954	2726	3095	4061	4572	4490	3290	25188
18	2699	1719	2112	2889	3268	3253	2894	18834
19	2386	1309	1611	2151	2405	2731	2323	14916
20	1683	1043	1287	1660	1913	2520	1955	12061
21	1534	780	903	1155	1377	1891	1464	9104
22	1142	569	723	748	921	1341	1182	6626
23	722	444	487	533	721	964	939	4810
Grand Total	41405	46337	40510	45028	54140	57961	54682	340063

Speeding Offense –
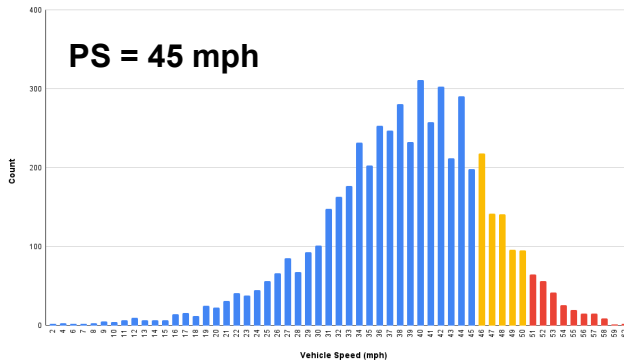# Non-CMV Distribution

Non-CMV Vehicle Speed at 55mph Sites

PS = 55 mph
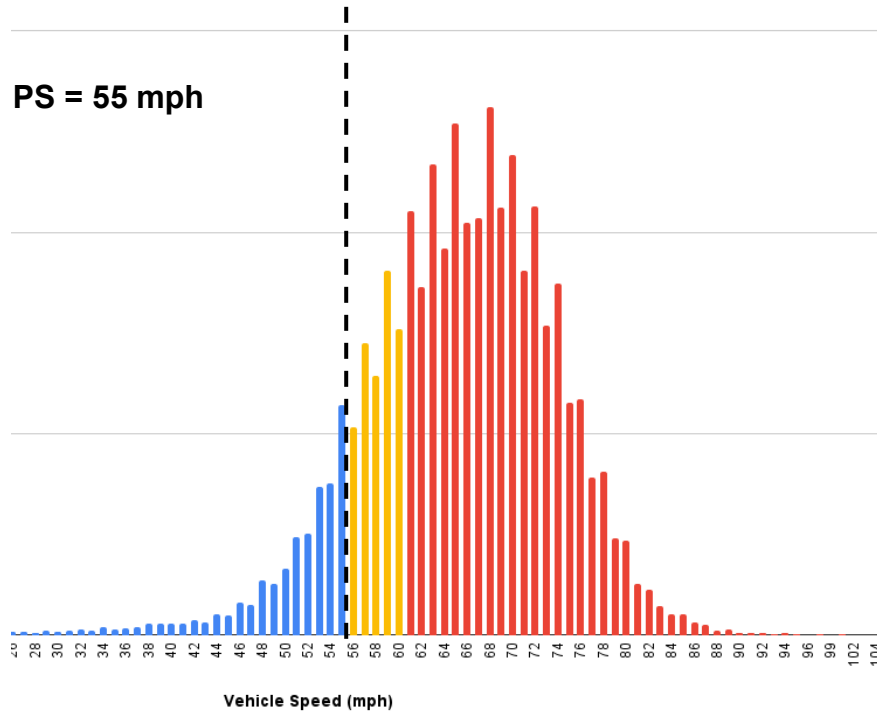
Vehicle Speed (mph)
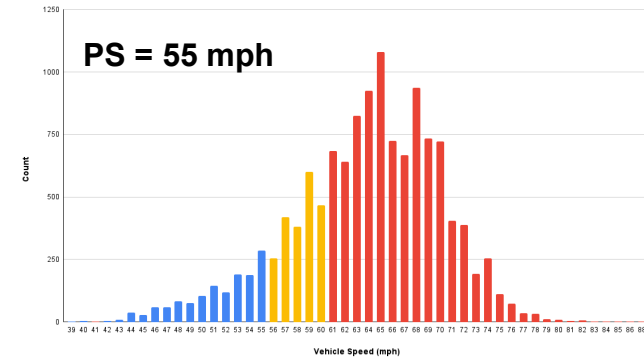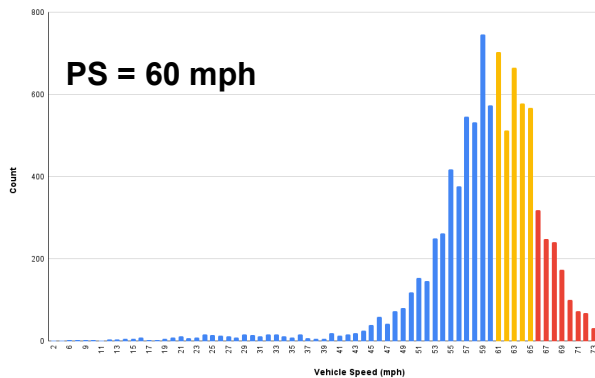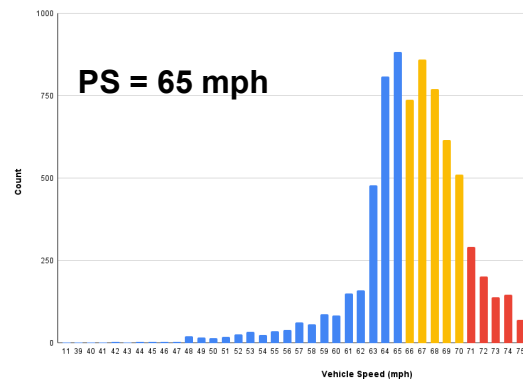
Non-CMV Vehicle Speed at 70mph Sites

PS = 70 mph

Vehicle Speed (mph)

Speeding Offense –
CMV Distributions
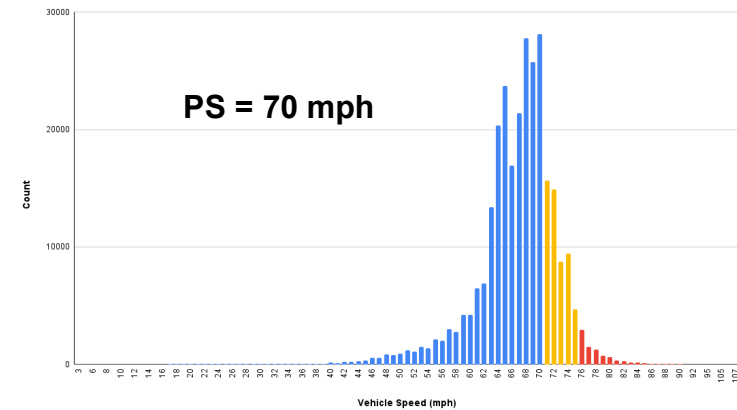
Summary Seatbelt & Phone Offense Rates

CMVs

	(a)	(b)	(c) = (b/a)	(d)	(e) = (d/a)
Date	CMV Detections	Phone Referred	Phone Referral Rate	Confirmed Phone	Phone Offense rate
Jan. – March 2025	319021	30505	9.56%	9686	3.04%

	(a)	(b)	(c) = (b/a)	(d)	(e) = (d/a)
Date	CMV Detections	Seatbelt Referred	Seatbelt Referral Rate	Confirmed Seatbelt	Seatbelt Offense rate
Jan. – March 2025	319021	55448	17.38%	16202	5.08%

Non-CMVs

	(a)	(b)	(c) = (b/a)	(d)	(e) = (d/a)
Date	Non-CMV Detections	Phone Referred	Phone Referral Rate	Confirmed Phone	Phone Offense rate
March – April 2025	340063	50795	14.94%	30030	8.83%

	(a)	(b)	(c) = (b/a)	(d)	(e) = (d/a)
Date	Non-CMV Detections	Seatbelt Referred	Seatbelt Referral Rate	Confirmed Seatbelt	Seatbelt Offense rate
March – April 2025	340063	74627	21.95%	25735	7.57%

Summary Offense Rates - CMVs

Incident Type	Average Offense Rate	Max Offense Rate	Max Offense Rate Site	Min Offense Rate	Min Offense Rate Site
Seatbelt	5.23%	7.86%	AU009 – NB US43	3.32%	AU002
Phone	2.99%	4.03%	AU007 – EB I22	1.50%	AU0019
Speed	26.12%	84.30%	AU0026 – EB I59	0.40%	AU0019
Speed (No Work Zone)	23.06%	56.62%	AU003 – SB US231	0.40%	AU0019

Incident Type	Average Offense Rate	Max Offense Rate	Max Offense Rate Day	Min Offense Rate	Min Offense Rate Day
Seatbelt	5.04%	5.60%	Saturday	4.57%	Monday
Phone	3.20%	3.62%	Sunday	3.03%	Wednesday
Speed (No Work Zone)	21.84%	24.52%	Monday	19.88%	Thursday

Incident Type	Average Offense Rate	Max Offense Rate	Max Offense Rate Hour	Min Offense Rate	Min Offense Rate Hour
Seatbelt	5.43%	7.94%	21:00	3.70%	07
Phone	3.05%	4.31%	20:00	2.16%	03
Speed (No Work Zone)	24.18%	25.97%	20:00	22.43%	08

Incident Type	Average Offense Rate	Max Offense Rate	Max Offense Rate Speed Zone	Min Offense Rate	Min Offense Rate Speed Zone
Seatbelt	5.65%	7.86%	45	3.45%	60
Phone	2.94%	3.70%	55	2.10%	60
Speed	44.83%	84.30%	55	15.46%	45
Speed (No Work Zone)	36.93%	56.62%	65	15.46%	45

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Seatbelt Offense- Distribution

CMVs

Hour	Day of the Week							
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
00	8.46%	7.73%	5.26%	6.93%	6.46%	7.09%	8.63%	7.09%
01	5.19%	7.20%	7.98%	5.36%	7.03%	6.40%	9.52%	7.07%
02	5.47%	4.87%	5.73%	6.90%	6.33%	5.70%	6.50%	6.00%
03	5.51%	6.41%	5.63%	6.51%	3.77%	6.60%	6.41%	5.87%
04	3.77%	6.69%	5.29%	5.91%	5.46%	5.88%	6.07%	5.73%
05	5.76%	4.61%	5.00%	5.41%	5.30%	5.75%	6.21%	5.41%
06	4.52%	4.34%	5.04%	4.98%	3.99%	4.85%	5.39%	4.72%
07	4.47%	2.93%	3.40%	4.37%	3.69%	3.55%	4.01%	3.70%
08	3.69%	4.01%	4.73%	4.26%	5.11%	4.63%	4.85%	4.54%
09	4.32%	4.38%	3.87%	4.31%	4.46%	4.64%	3.86%	4.30%
10	4.85%	3.96%	4.10%	3.75%	3.60%	4.24%	4.50%	4.06%
11	5.12%	3.78%	4.11%	4.29%	3.52%	3.32%	4.48%	3.97%
12	4.90%	3.89%	3.79%	4.45%	4.22%	4.62%	4.63%	4.32%
13	4.74%	4.12%	4.22%	2.79%	4.28%	5.11%	4.58%	4.27%
14	4.94%	3.67%	4.23%	3.38%	3.89%	4.15%	5.17%	4.10%
15	4.18%	3.92%	4.57%	4.16%	4.00%	3.44%	5.36%	4.17%
16	5.10%	3.32%	4.15%	4.48%	4.42%	4.32%	4.54%	4.27%
17	5.21%	3.92%	5.15%	4.47%	4.67%	4.75%	5.65%	4.76%
18	5.96%	5.32%	6.07%	4.96%	5.67%	6.23%	7.28%	5.83%
19	7.79%	6.20%	6.41%	5.93%	7.14%	6.86%	7.10%	6.73%
20	6.85%	7.60%	5.93%	6.22%	8.18%	7.71%	7.54%	7.22%
21	7.49%	6.97%	7.51%	7.69%	8.54%	8.49%	8.76%	7.94%
22	7.22%	6.76%	7.68%	6.29%	6.39%	7.98%	8.36%	7.16%
23	7.93%	6.20%	6.94%	6.29%	6.77%	9.30%	5.89%	7.09%
Grand Total	5.39%	4.67%	4.96%	4.87%	4.97%	5.28%	5.66%	5.08%

Non-CMVs

Hour	Day of the Week							
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
00	15.21%	8.79%	13.04%	15.86%	15.38%	14.22%	12.65%	13.44%
01	15.14%	7.49%	13.04%	13.52%	14.29%	16.67%	12.39%	13.25%
02	17.04%	7.83%	10.91%	14.72%	14.67%	11.44%	11.78%	12.49%
03	14.17%	7.64%	8.36%	17.85%	13.61%	13.41%	10.74%	12.13%
04	10.18%	7.59%	7.56%	13.60%	13.84%	17.60%	10.39%	11.55%
05	9.97%	11.70%	7.94%	14.45%	16.00%	12.69%	10.00%	12.22%
06	5.61%	9.85%	6.33%	12.36%	12.06%	11.19%	8.18%	10.00%
07	6.37%	5.41%	6.85%	8.53%	8.33%	9.56%	7.20%	7.59%
08	6.91%	6.74%	6.81%	7.43%	9.29%	7.96%	6.84%	7.45%
09	5.56%	5.67%	8.39%	6.77%	6.45%	8.05%	6.44%	6.69%
10	4.57%	4.81%	6.37%	3.82%	6.72%	7.39%	6.44%	5.81%
11	5.40%	4.50%	5.43%	3.39%	5.83%	5.61%	5.62%	5.20%
12	5.10%	5.22%	5.89%	3.76%	5.23%	4.53%	5.98%	5.17%
13	5.90%	5.83%	5.36%	3.21%	4.27%	4.65%	6.10%	5.16%
14	5.90%	5.08%	6.69%	4.89%	5.54%	5.42%	4.40%	5.37%
15	6.97%	3.87%	8.91%	6.04%	6.37%	5.72%	4.75%	6.05%
16	7.13%	5.50%	10.03%	6.75%	7.93%	6.44%	5.93%	7.10%
17	7.24%	5.94%	11.53%	8.08%	7.90%	7.37%	7.02%	7.88%
18	9.37%	8.73%	13.30%	9.03%	9.67%	7.84%	7.22%	9.16%
19	8.30%	9.24%	12.60%	10.97%	10.94%	9.63%	9.69%	10.12%
20	7.61%	8.72%	14.06%	11.45%	12.39%	7.82%	9.41%	10.02%
21	9.19%	12.31%	10.74%	11.77%	10.97%	10.74%	11.41%	10.89%
22	7.79%	10.90%	15.49%	12.03%	12.70%	11.56%	13.71%	11.88%
23	4.85%	17.57%	13.96%	17.82%	12.21%	12.86%	13.31%	12.74%
Grand Total	7.01%	6.50%	8.70%	7.93%	8.19%	7.63%	7.08%	7.57%

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Phone Offense- Distribution

CMVs

Hour	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
00	3.76%	3.80%	3.32%	3.23%	3.49%	2.71%	3.40%	3.31%
01	3.94%	3.13%	3.80%	3.31%	1.69%	1.58%	2.53%	2.68%
02	3.19%	2.43%	2.62%	2.37%	2.69%	3.34%	3.01%	2.80%
03	1.22%	2.43%	1.93%	2.56%	1.77%	2.37%	2.25%	2.16%
04	2.64%	2.86%	2.47%	2.68%	2.85%	1.92%	2.95%	2.59%
05	2.65%	2.48%	2.01%	2.62%	2.70%	1.95%	3.26%	2.47%
06	1.59%	2.67%	3.79%	2.14%	2.46%	2.49%	3.15%	2.68%
07	2.91%	2.51%	2.12%	2.92%	2.04%	2.36%	3.26%	2.50%
08	1.81%	2.58%	3.17%	2.07%	2.76%	2.96%	2.88%	2.67%
09	3.33%	2.79%	2.82%	3.25%	2.74%	3.20%	2.72%	2.96%
10	2.98%	3.11%	3.08%	2.87%	3.21%	2.72%	3.72%	3.09%
11	2.88%	1.87%	2.95%	2.85%	2.94%	2.55%	3.60%	2.79%
12	3.44%	2.38%	2.62%	3.42%	1.93%	3.28%	2.75%	2.78%
13	4.09%	2.90%	2.97%	2.34%	2.87%	2.75%	2.26%	2.85%
14	3.96%	3.53%	2.96%	3.56%	2.85%	2.86%	3.12%	3.22%
15	3.14%	2.57%	2.50%	2.68%	2.82%	2.30%	2.74%	2.66%
16	4.21%	2.93%	2.65%	2.93%	3.45%	2.93%	3.33%	3.14%
17	2.64%	4.05%	3.86%	3.22%	2.94%	3.29%	3.17%	3.33%
18	3.77%	3.53%	3.57%	3.60%	2.69%	3.63%	3.49%	3.43%
19	4.86%	4.60%	3.56%	3.18%	3.61%	4.05%	4.44%	3.94%
20	4.48%	3.90%	3.84%	3.96%	4.95%	4.03%	5.13%	4.31%
21	4.05%	5.41%	4.55%	2.71%	3.38%	3.62%	4.86%	3.97%
22	3.56%	3.47%	3.53%	3.24%	3.91%	4.40%	2.83%	3.65%
23	4.33%	3.51%	2.89%	2.67%	2.86%	3.67%	3.17%	3.24%
Grand Total	3.39%	3.07%	3.03%	2.95%	2.91%	2.94%	3.20%	3.04%

Non-CMVs

Hour	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
00	7.53%	10.25%	9.09%	12.07%	11.69%	11.08%	12.20%	10.42%
01	7.57%	15.31%	10.43%	11.07%	9.86%	13.94%	9.40%	10.95%
02	9.65%	13.33%	10.45%	12.99%	10.81%	12.09%	9.24%	11.23%
03	9.45%	12.29%	12.27%	13.27%	12.31%	13.60%	7.71%	11.86%
04	6.91%	12.07%	9.88%	10.01%	12.42%	12.93%	7.84%	10.87%
05	8.31%	9.40%	9.06%	9.47%	10.34%	9.10%	6.58%	9.16%
06	5.61%	10.92%	10.03%	10.45%	9.70%	9.79%	7.60%	9.76%
07	5.79%	11.49%	11.20%	11.68%	9.81%	10.69%	8.14%	10.40%
08	8.38%	11.32%	10.02%	10.56%	10.46%	9.33%	8.17%	9.83%
09	6.41%	10.22%	9.02%	8.38%	8.86%	7.54%	6.64%	8.11%
10	6.57%	8.22%	6.51%	5.71%	7.93%	7.43%	6.33%	6.98%
11	6.62%	7.46%	5.30%	4.06%	7.46%	8.44%	4.28%	6.37%
12	5.24%	8.70%	4.58%	4.06%	5.35%	6.85%	5.63%	5.98%
13	7.48%	9.54%	5.14%	4.34%	5.45%	7.68%	5.89%	6.72%
14	8.10%	9.64%	6.48%	6.23%	7.21%	8.63%	5.56%	7.47%
15	8.20%	10.65%	10.42%	7.98%	8.47%	8.30%	5.82%	8.40%
16	8.33%	12.84%	10.80%	10.37%	9.30%	10.00%	6.09%	9.62%
17	9.72%	11.63%	12.25%	11.23%	10.54%	9.24%	7.36%	10.24%
18	10.52%	12.39%	12.83%	12.15%	10.68%	10.05%	8.09%	10.77%
19	10.69%	11.15%	11.05%	10.32%	10.98%	11.28%	8.48%	10.53%
20	10.52%	10.74%	11.34%	10.48%	10.04%	9.56%	9.26%	10.14%
21	10.63%	13.97%	11.41%	10.39%	10.53%	10.47%	7.79%	10.46%
22	13.40%	14.41%	11.34%	10.29%	10.10%	9.62%	10.07%	11.09%
23	12.33%	14.86%	13.14%	14.26%	12.76%	11.00%	9.69%	12.14%
Grand Total	8.33%	10.49%	9.21%	9.07%	8.94%	9.16%	6.86%	8.83%

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All Offense Rates Per PS Limit

CMVs
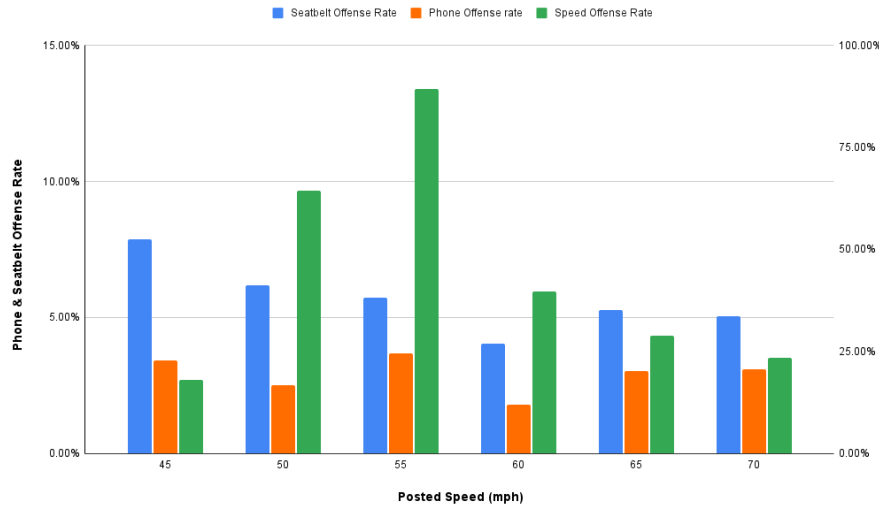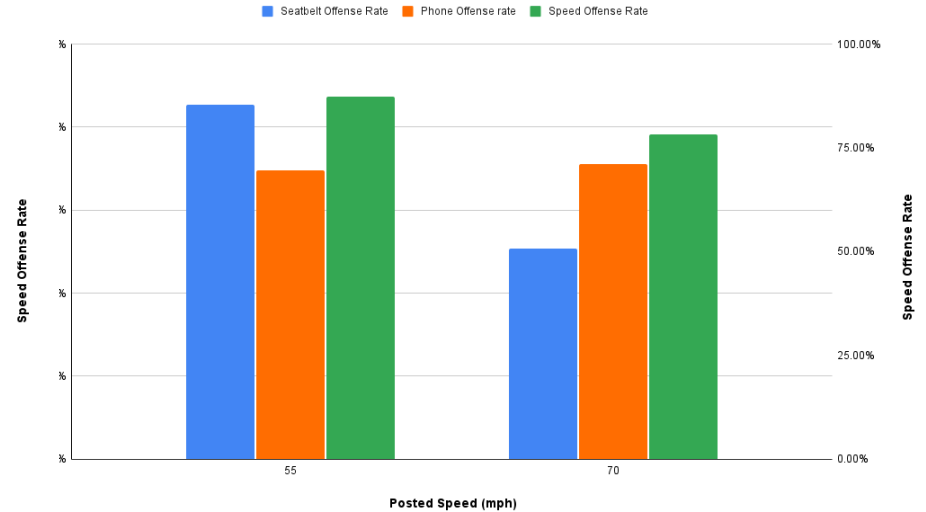
Non-CMVs

Speed Limit	Seatbelt Offense Rate	Phone Offense rate	Speed Offense Rate
45	7.86%	3.41%	18.02%
50	6.18%	2.51%	64.39%
55	5.74% (10.67%)*	3.70% (8.71%)*	89.20% (87.34%)*
60	3.45%	2.10%	39.69%
65	5.66%	2.89%	28.98%
70	5.03% (6.35%)*	3.04% (8.88%)*	23.39% (78.23%)*
*non-CMV values			

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Multiple Offences

- Committing more than 1 offense at the same time:
  - Approximately 8% of CMVs (1 in 12)
  - About 15% of non-CMVs (1 in 6)

- Over 94% of multiple offenses are two-offenses

- Top multiple offenses:
  - Phone + speeding for Non-CMVs
  - Seatbelt + speeding for CMVs

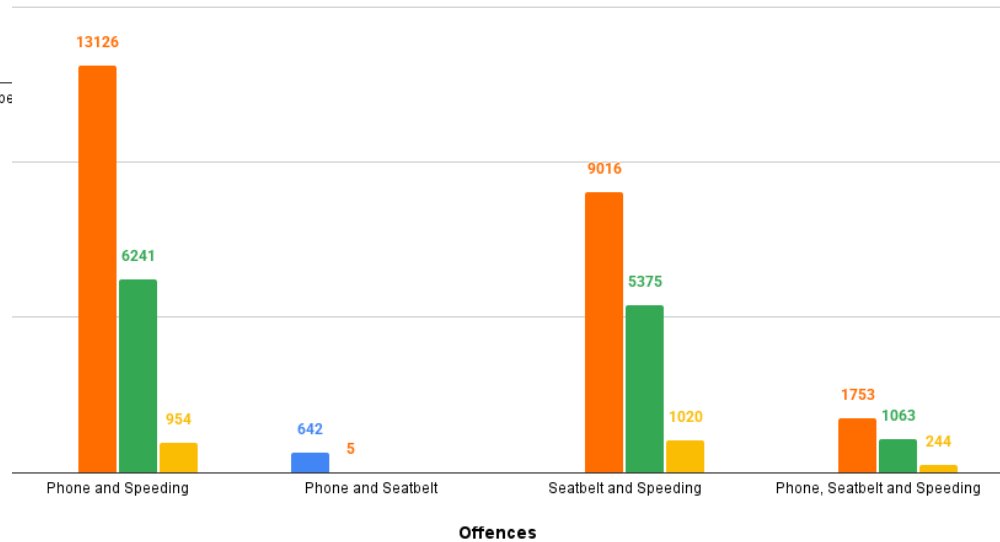| Multiple Offenses	CMV Count (%)	Non-CMV Count (%)
Phone and Seatbelt	1,061 (13%)	745 (2%)
Phone and Speeding	2,021 (26%)	21,265 (50%)
Seatbelt and Speeding	4,340 (55%)	17,361 (41%)
Phone, Seatbelt and Speeding	482 (6%)	3,329 (8%)

Multiple Offences

Multiple Offences By Speed Over Bin

■ 0 mph ■ 1-10 mph ■ 11-20 mph ■ 21-30 mph

CMVs

- Phone and Speeding: 1852, 168, 1
- Phone and Seatbelt: 1053, 8
- Seatbelt and Speeding: 3983, 348, 9
- Phone, Seatbelt and Speeding: 441, 41
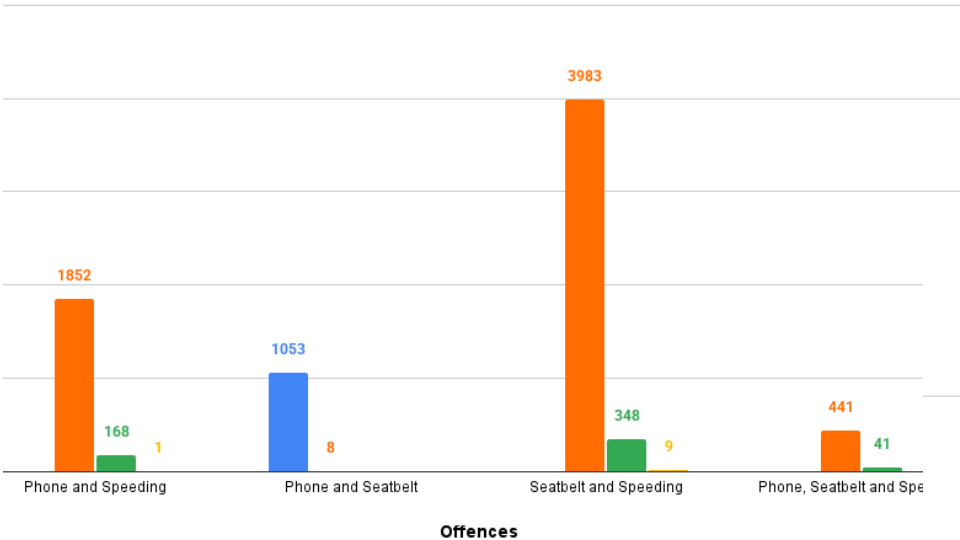
Offences

Non-CMV Multiple Offences By Speed Over Bin

■ 0 mph ■ 1-10 mph ■ 11-20 mph ■ 21-30 mph

Non-CMVs

- Phone and Speeding: 13126, 6241, 954
- Phone and Seatbelt: 642, 5
- Seatbelt and Speeding: 9016, 5375, 1020
- Phone, Seatbelt and Speeding: 1753, 1063, 244

Offences

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Site Code: AU0026   System: Trailer-609   Direction: Towards   Operator: 011
Location: I59 NB @ 141mm   Deployed Position: Within 16.5m of 33.638385, -86.619149
Incident Number: 32608   Lane: 1   Offense: Mobile Phone Use   Vehicle Speed: 71 mph
Date: 29 March 2025   Time: 15:08:20.693   Elapsed Time: 0.000

Site Code: AU0026   System: Trailer-609   Direction: Towards   Operator: 011
Location: I59 NB @ 141mm   Deployed Position: Within 16.5m of 33.638385, -86.619149
Incident Number: 32608   Lane: 1   Offense: Mobile Phone Use   Vehicle Speed: 71 mph
Date: 29 March 2025   Time: 15:08:20.916   Elapsed Time: 0.223

Site Code: AU0026   System: Trailer-609   Direction: Towards   Operator: 011
Location: I59 NB @ 141mm   Deployed Position: Within 16.5m of 33.638385, -86.619149
Incident Number: 32608   Lane: 1   Offense: Mobile Phone Use   Vehicle Speed: 71 mph
Date: 29 March 2025   Time: 15:08:21.205   Elapsed Time: 0.513

Site Code: AU0026   System: Trailer-609   Direction: Towards   Operator: 011
Location: I59 NB @ 141mm   Deployed Position: Within 16.5m of 33.638385, -86.619149
Incident Number: 32608   Lane: 1   Offense: Mobile Phone Use   Vehicle Speed: 71 mph
Date: 29 March 2025   Time: 15:08:20.746   Elapsed Time: 0.053

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Site Code: AU0022 System: Trailer-604 Direction: Towards Operator: 011
Location: EB on I-10 Deployed Position: Within 22.4m of 30.602218, -87.556364
Incident Number: 102940320 Lane: 1 Offense: Mobile Phone Use Vehicle Speed: 72 mph
Date: 28 March 2025 Time: 21:08:39.934 Elapsed Time: 0.000

Site Code: AU0022 System: Trailer-604 Direction: Towards Operator: 011
Location: EB on I-10 Deployed Position: Within 22.4m of 30.602218, -87.556364
Incident Number: 102940320 Lane: 1 Offense: Mobile Phone Use Vehicle Speed: 72 mph
Date: 28 March 2025 Time: 21:08:40.097 Elapsed Time: 0.163

Site Code: AU0022 System: Trailer-604 Direction: Towards Operator: 011
Location: EB on I-10 Deployed Position: Within 22.4m of 30.602218, -87.556364
Incident Number: 102940320 Lane: 1 Offense: Mobile Phone Use Vehicle Speed: 72 mph
Date: 28 March 2025 Time: 21:08:39.982 Elapsed Time: 0.048
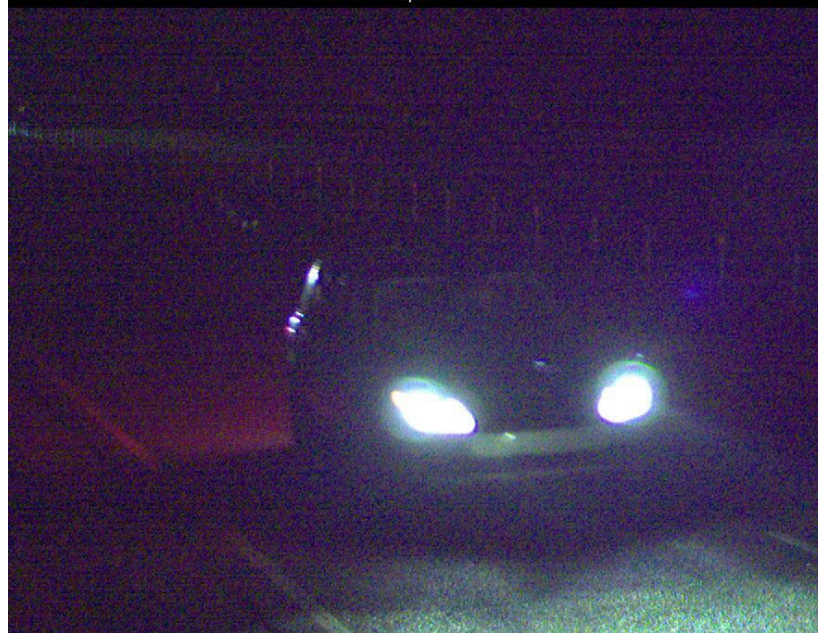
Site Code: AU0022 System: Trailer-604 Direction: Towards Operator: 011
Location: EB on I-10 Deployed Position: Within 22.4m of 30.602218, -87.556364
Incident Number: 102940320 Lane: 1 Offense: Mobile Phone Use Vehicle Speed: 72 mph
Date: 28 March 2025 Time: 21:08:40.389 Elapsed Time: 0.455

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Site Code: AU0026 System: Trailer-609 Direction: Towards Operator: 011
Location: I59 NB @ 141mm Deployed Position: Within 16.5m of 33.638385, -86.619149
Incident Number: 14025 Lane: 1 Offense: Mobile Phone Use Vehicle Speed: 57 mph
Date: 31 March 2025 Time: 10:30:40.620 Elapsed Time: 0.000

Site Code: AU0026 System: Trailer-609 Direction: Towards Operator: 011
Location: I59 NB @ 141mm Deployed Position: Within 16.5m of 33.638385, -86.619149
Incident Number: 14025 Lane: 1 Offense: Mobile Phone Use Vehicle Speed: 57 mph
Date: 31 March 2025 Time: 10:30:40.906 Elapsed Time: 0.285

Site Code: AU0026 System: Trailer-609 Direction: Towards Operator: 011
Location: I59 NB @ 141mm Deployed Position: Within 16.5m of 33.638385, -86.619149
Incident Number: 14025 Lane: 1 Offense: Mobile Phone Use Vehicle Speed: 57 mph
Date: 31 March 2025 Time: 10:30:40.732 Elapsed Time: 0.112

Site Code: AU0026 System: Trailer-609 Direction: Towards Operator: 011
Location: I59 NB @ 141mm Deployed Position: Within 16.5m of 33.638385, -86.619149
Incident Number: 14025 Lane: 1 Offense: Mobile Phone Use Vehicle Speed: 57 mph
Date: 31 March 2025 Time: 10:30:41.254 Elapsed Time: 0.634

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Site Code: AU001 System: Trailer-604 Direction: Towards Operator: 200
Location: SB on I-65 Deployed Position: Within 19.8m of 31.928905, -86.572758
Incident Number: 7577 Lane: 1 Offense: Mobile Phone Use Vehicle Speed: 65 mph
Date: 21 January 2025 Time: 10:43:09.463 Elapsed Time: 0.000

Site Code: AU001 System: Trailer-604 Direction: Towards Operator: 200
Location: SB on I-65 Deployed Position: Within 19.8m of 31.928905, -86.572758
Incident Number: 7577 Lane: 1 Offense: Mobile Phone Use Vehicle Speed: 65 mph
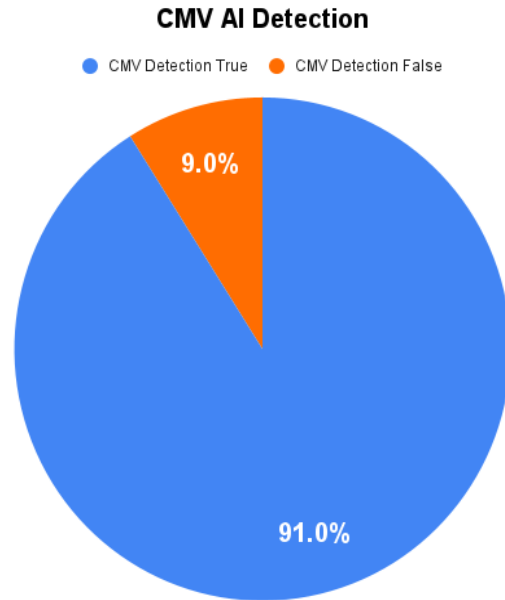Date: 21 January 2025 Time: 10:43:09.690 Elapsed Time: 0.227

Site Code: AU001 System: Trailer-604 Direction: Towards Operator: 200
Location: SB on I-65 Deployed Position: Within 19.8m of 31.928905, -86.572758
Incident Number: 7577 Lane: 1 Offense: Mobile Phone Use Vehicle Speed: 65 mph
Date: 21 January 2025 Time: 10:43:09.517 Elapsed Time: 0.054

Site Code: AU001 System: Trailer-604 Direction: Towards Operator: 200
Location: SB on I-65 Deployed Position: Within 19.8m of 31.928905, -86.572758
Incident Number: 7577 Lane: 1 Offense: Mobile Phone Use Vehicle Speed: 65 mph
Date: 21 January 2025 Time: 10:43:09.989 Elapsed Time: 0.526

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AI Performance

- Detections

CMV AI Detection

● CMV Detection True ● CMV Detection False

9.0%

91.0%

91% of AI referrals for human review were correctly identified as CMVs.

- Weather

Road Conditions	CMV Detections	Drivers not found	Driver not found rate
Snowing	1197	926	77.4%
Clear	14342	4747	33.1%

AI Performance

Metric							
Trailer	T609	T604	T609	T609	T609	T604	T604
Start time	2025-01-23	2025-01-23	2025-03-06 22:15:19	2025-03-17 01:09:02	2025-04-10 22:36:58	2025-03-25 23:58:17	2025-04-02 01:04:33
End time	2025-03-04	2025-03-04	2025-03-17 01:08:35	2025-04-01 21:00:14	2025-04-13 23:47:43	2025-04-02 00:29:00	2025-04-11 23:36:00
Configuration	CMV only; generic phone and SB models	CMV only; generic phone and SB models	CMV only; specialist 'heavy' phone mode	CMV only; adjust thresholds.	All traffic; updated (latest) SB model.	Light (non-CMV); phone model	Light (non-CMV); updated SB model
Total volume of radar detections	438119	682201	155042	213680	1687	157086	138087
Total detected occupants	508780	757415	177948	241699	1702	179495	153467
Proportion of DriverNotFound	9.07 %	15.40 %	5.86 %	14.61 %	11.03 %	13.32 %	8.70 %
Phone Precision	35.42 %	29.10 %	28.08 %	30.49 %	38.71 %	58.82 %	59.02 %
Seat-belt Precision	25.92 %	28.23 %	34.35 %	28.12 %	27.20 %	34.70 %	49.94 %

It is not possible to establish how many offences were potentially missed by the AI, without control testing.

Control Site – Layout & Test Vehicles

Control Site Testing Plan

- Test Vehicles:
    - Two CMVs (NCAT drivers and vehicle rental)
    - Four non-CMVs (AUTRI drivers)
- Testing Attributes
    - Speeds (4no)
        - 45 to 75 mph @ 10 mph increments
    - Fake "Unsafe" behaviors (4no)
        - Distracted (phone & other)
        - Improper seatbelt & No seatbelt
    - Driver attributes (4no)
        - Shirt color etc.
    - Driving conditions (4no)
        - Day and night
        - Others (Wiper+Fluid On & Off)
    - Safe driving conditions
        - Belted + no distraction

Control Site Testing Plan

- Test vehicle settings:
  - Dashcam
    - Record in-vehicle activities
  - Outside camera setup
    - Record AI trailer and testing environment

- Testing Hours:
  - Non-CMVs
    - All day on Sunday (4/13) and on Monday(4/14) before 4 pm ~ 20 hours
  - CMV
    - After the first NCAT shift from Tuesday (4/15) to Friday (4/18) ~ 25 hours

of AI Detections
(Before Human Review)

$PHONE\ USE:\quad True\ Positive\ Rate\ (Recall) = \dfrac{TP}{All\ actual\ positives}$

$$Non-CMVs = \frac{294}{352} = 83.5\% \qquad\qquad CMVs = \frac{202}{288} = 70.1\%$$

$UNBELTED:\quad True\ Positive\ Rate\ (Recall) = \dfrac{TP}{All\ actual\ positives}$

$$Non-CMVs = \frac{614}{673} = 91.2\% \qquad\qquad CMVs = \frac{485}{592} = 81.9\%$$

Camera Code: Auburn Control Site   Direction: Towards   Operator: 011
Location: Auburn Control Track
Incident Number: 6811   Lane: 2   Offence: Mobile Phone Use   Vehicle Speed: 45 mph
Date: 17 April 2025   Time: 14:40:07.238

Incident Number:
6811

False Positive:
Phone Use

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Concluding Remarks

Concluding Remarks

- Offense rates were:
  - CMVs: 3%, 5%, and 24% for phone use, unbelted conditions, and speeding, respectively.
  - Non-CMVs: 9%, 8%, and 81%
  - WZ Speeding was exceptionally high (89% & 93%).
  - Multiple offenses:
    - 1 in 12 CMVs – mostly speeding + unbelted
    - 1 in 6 non-CMVs – mostly speeding + phone

- AI detection precision for specific offenses were:
  - CMVs: 32% for phone use & 29% for unbelted conditions.
  - Non-CMVs: 59% for phone use & 42% for unbelted cond.

Concluding Remarks

- There is the potential for the AI model to be adjusted to increase capture rate but also raise reviewing workload.
  - Optimal settings depends on the application
    - E.g., If used for real time enforcement and ticketing;
    - The goal is to minimize **False Positives or Alarms**
    - The human reviewers will be more cautious to ensure a high practical reliability for enforcement.

Thank You!

Acknowledgment

- **FMCSA - HP Grant Funding**
- **ALDOT – ROW Permission**
- **Project Advisory Panel Members**

Contact Info: 👉

# Brief Background – National Statistics

Drivers Involved in Fatal Traffic Crashes, by Age Group, Distraction, and Cellphone Use, 2023

Age Group	Total Drivers		Distracted Drivers			Drivers Using Cellphones		
	Number	Percentage of Total Drivers	Number	Percentage of Total Drivers in This Age Group	Percentage of Distracted Drivers	Number	Percentage of Distracted Drivers in This Age Group	Percentage of Drivers Using Cellphones
15–20	5,133	9%	348	7%	11%	55	16%	15%
21–24	5,101	9%	298	6%	9%	48	16%	13%
25–34	11,916	21%	710	6%	23%	88	12%	24%
35–44	9,876	17%	545	6%	17%	73	13%	20%
45–54	8,116	14%	366	5%	12%	43	12%	12%
55–64	7,560	13%	358	5%	11%	37	10%	10%
65–74	4,954	9%	250	5%	8%	21	8%	6%
75+	3,458	6%	188	5%	6%	3	2%	1%
Total	57,939	100%	3,143	5%	100%	371	12%	100%

Source: FARS 2023 ARF

Notes: The total includes 93 drivers 14 and younger, 8 of whom were noted as distracted. Additionally, the total includes 1,732 of unknown age, 72 of whom were noted as distracted.

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Figure 1-2: Comparison of Alabama and National Seat Belt Use Rates
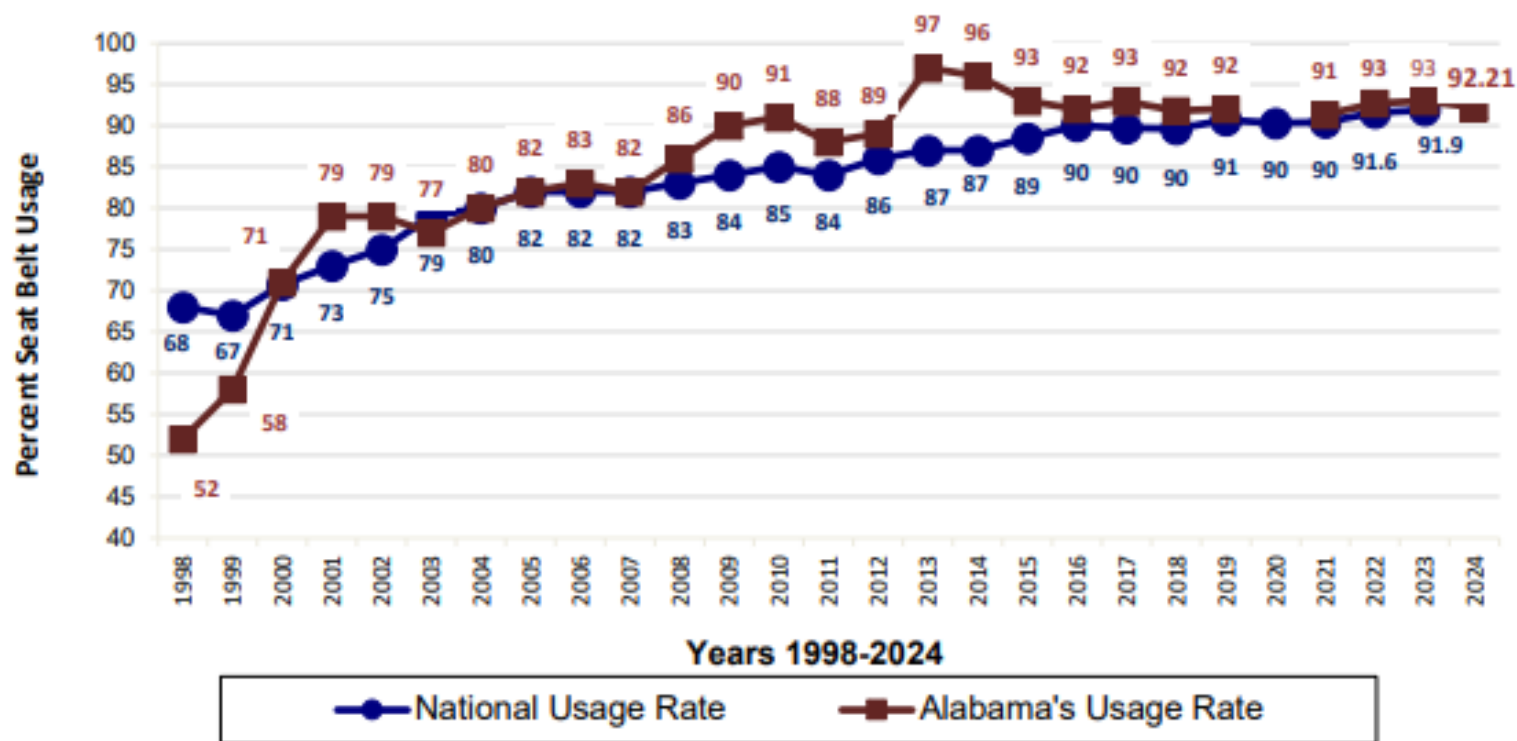
Source for 2024 Alabama Usage Rate: 2024 Observational Survey

*The redesigned observational survey sampling and estimation plan has been implemented since 2013.
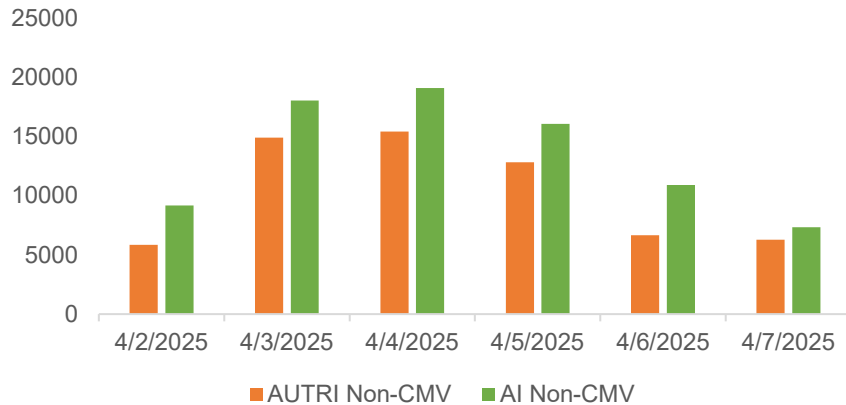
AI Identification

&

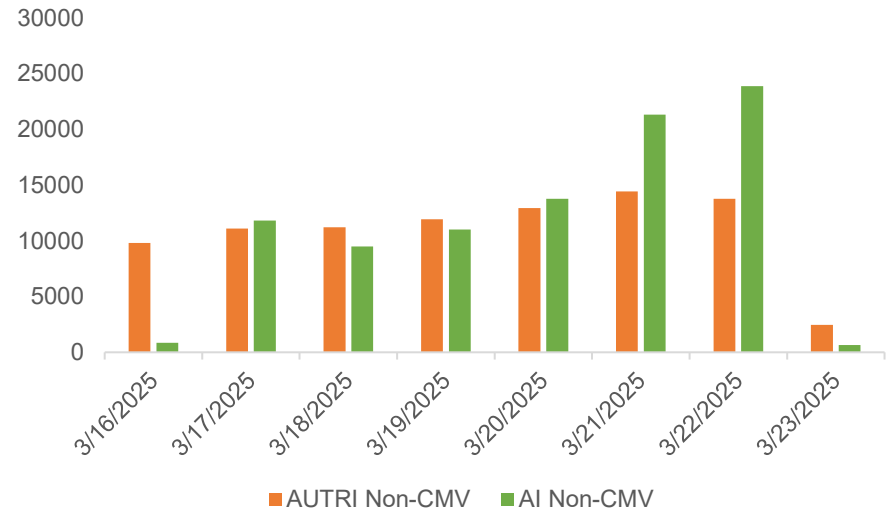# Offence Protocol

Microsoft Word
Document

Data Classification
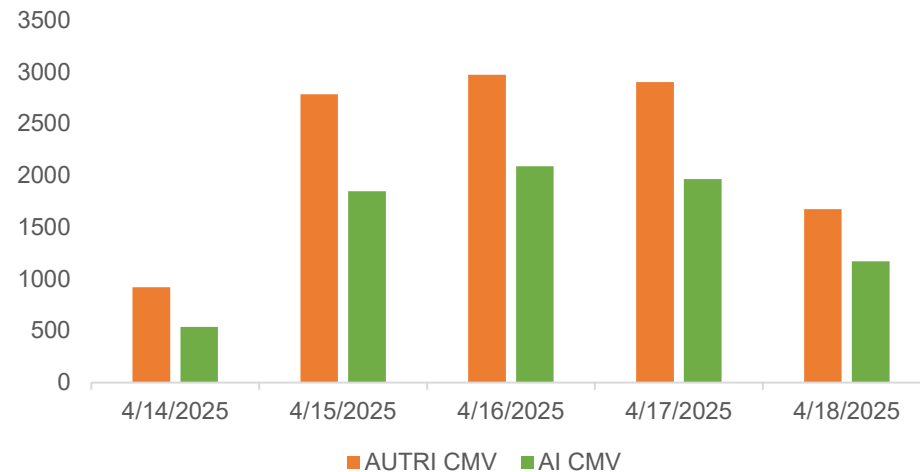
- Mean Absolute Percentage Difference = 20%

SB I-65

EB I-59

NCAT Test Track

of AI Detections
(After Human Review)

$PHONE\ USE$: $True\ Positive\ Rate\ (Recall) = \dfrac{TP}{All\ actual\ positives}$

$$Non-CMVs = \frac{56}{352} = 15.9\%$$ $$CMVs = \frac{154}{288} = 53.5\%$$

$UNBELTED$: $True\ Positive\ Rate\ (Recall) = \dfrac{TP}{All\ actual\ positives}$

$$Non-CMVs = \frac{88}{673} = 13.1\%$$ $$CMVs = \frac{3}{592} = 0.5\%$$

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False Positive Rates (False Alarm) (After Human Review)

$$PHONE\ USE: \ False\ Positive\ Rate\ (False\ Alarm) = \frac{FP}{All\ actual\ negatives}$$

$$Non-CMVs = 7.7\% \qquad CMVs = 6.7\%$$

$$UNBELTED: \ False\ Positive\ Rate\ (False\ Alarm) = \frac{FP}{All\ actual\ negatives}$$

$$Non-CMVs = 0.2\% \qquad CMVs = 19.8\%$$

Summary Offense Rates – Non CMVs

Incident Type	Average Offense Rate	Max Offense Rate	Max Offense Rate Site	Min Offense Rate	Min Offense Rate Site
Seatbelt	9.13%	16.68%	AU0024	5.39%	AU001
Phone	8.53%	9.98%	AU0021	6.81%	AU0024
Speed	76.39%	93.20%	AU0026	56.30%	AU0024

Incident Type	Average Offense Rate	Max Offense Rate	Max Offense Rate Day	Min Offense Rate	Min Offense Rate Day
Seatbelt	7.58%	8.70%	Tuesday	6.50%	Monday
Phone	8.87%	10.49%	Monday	6.86%	Saturday
Speed	80.39%	86.46%	Saturday	73.83%	Tuesday

Incident Type	Average Offense Rate	Max Offense Rate	Max Offense Rate Hour	Min Offense Rate	Min Offense Rate Hour
Seatbelt	9.14%	13.44%	00	5.16%	13
Phone	9.56%	12.14%	23	5.98%	12
Speed (No Work Zone)	81.00%	85.10%	18	76.08%	02

Incident Type	Average Offense Rate	Max Offense Rate	Max Offense Rate Speed Zone	Min Offense Rate	Min Offense Rate Speed Zone
Seatbelt	8.51%	10.67%	55	6.35%	70
Phone	8.79%	8.88%	70	8.71%	55
Speed	82.79%	87.34%	55	78.23%	70
Speed (No Work Zone)	36.93%	56.62%	65	15.46%	45