Analyzing Side Underride Crashes and Fatalities: An Examination Using Data from the Fatality Analysis Reporting System for the Years 2007 to 2020

The purpose of this study is to use data cataloged in the Fatality Analysis Reporting System (FARS) to estimate the number of side underride crashes and fatalities that occurred in the United States from 2007 to 2020.

The National Highway Traffic Safety Administration (NHTSA) is the federal agency charged with transportation safety within the U.S. Department of Transportation (USDOT). As part of their operations, NHTSA manages and maintains FARS. The FARS, which became operational in 1975, collects data from all 50 States, the District of Columbia, and Puerto Rico under Cooperative Agreements to report a standard set of data elements on each fatal vehicle crash within their jurisdictions (e.g., see NHTSA 2022; 87 FR 19573). To be included in the FARS database, a crash must involve a motor vehicle traveling on a traffic way customarily open to the public and must result in the death of a vehicle occupant or a nonoccupant within 30 days (NHTSA 2024). FARS is populated using data from each State's Police Crash Reporting form regarding all fatal crashes. The FARS database is the official "crash record" for fatal collisions throughout the United States and the sole source for cataloging deaths from underride crashes (National Center for Statistics and Analysis (NCSA) 2023, USDOT 2022).

For this report, a customized query was developed using the Fatality and Injury Reporting System Tool (FIRST Query (2007-2020 Final File; Report Generated: Tuesday, January 30, 2024 Version 7, Released Jan 24, 2024; NCSA 2023, USDOT 2022) to locate putative recorded side underride crashes in FARS from 2007 to 2020 by:

1. Expanding under the "Vehicles" heading, the tab "Select Fatality and/or Injury" to choose "Vehicles Involved in Fatal Crashes";

2. Expanding the tab under "Select Time Frame" and within the "Years" tab select 2007 to 2020;

3. Expanding the tab under "Filter Your Selection (FYS)" to expand the "Crash: General Characteristics" tab and within "Manner of Collision" select "Angle" and "Sideswipe";

4. Expanding the tab under "Crash: Specific Scenario/Event" and within the "Involving A Large Truck" tab select "Yes"; and

5. Expanding the tab under "Vehicle: Vehicle Characteristics/Event" and within the "Underride/Override" tab select "WITH MOTOR VEHICLE IN TRANSPORT" and "WITH MOTOR VEHICLE NOT IN TRANSPORT".

Using these data elements and attributes in a FIRST Query, a table containing the number of side underride crashes in the United States was created. Next, the number of fatalities and vehicles involved in each side underride crash were compiled by clicking the link within each of the table's crash cells to view the corresponding fatal crash records on a web map. Crash layers for

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each of the years were opened (toggled on) on the web map to display point locations of vehicles involved in fatal side underride crashes. Each crash point location on the web map (Figure 1) was opened to obtain the number of fatalities and the number of vehicles in the side underride crash. The number of side underride crashes, resulting fatalities, and number of vehicles involved were tabulated by the corresponding years and months (Table 1, Table 2, Table 3).

Using these data elements and attributes in a FIRST Query, a table containing the number of side underride crashes was also created for each State. Each State's side underride crash point locations were displayed on a web map (e.g., Figure 2). Each crash point location on the web map was opened to verify and obtain the number of fatalities and the number of vehicles in the side underride crash. The number of side underride crashes, resulting fatalities, the number of vehicles, and the number of crashes with greater than 2 vehicles involved were tabulated for each State (Table 4). Finally, a FIRST Query was run to tabulate the number of side underride crashes by trafficway class (i.e., Interstate, US Highway, or State Highway).

In the United States from 2007 to 2020, there were at least 1,238 side underride crashes with 1,415 fatalities cataloged in FARS, with 78 percent of these crashes (n=966) occurring on Interstates, U.S. Highways, and State Highways (Figure 1; Table 1). On these types of roadways, the average speed differential between passenger vehicles (mean speed=60.1 mph) and semitrucks/trailers (mean speed=57.3 mph) is 2.8 mph (NHTSA 2018), an order of magnitude less than 50 mph, the speed at which side underride guards are highly effective (Bodapati 2004, Moradi et al. 2011, Moradi 2012, Galipeau-Belair et al. 2013, Galipeau-Belair 2014, Insurance Institute for Highway Safety 2017, Wilson 2017, NHTSA 2018, Ponder 2018, Mattos et al. 2021, Airflow 2022, CBS News 2022, SafetySkirt 2023).

The Government Accountability Office (2019) identified underreporting of underride crashes and fatalities due to variability in the State's data collection. Consequently, following the methodology of NCSA (2023a), three "undercount correction factors" were applied to the side underride data cataloged in FARS (Table 1, Table 2, Table 3) to estimate the number of side underride crashes and resulting fatalities (Table 5). Specifically, NHTSA (2023a) corrected for FARS underreported of the number of side underride crashes using correction factor of 1.77; Hein (2023) estimated a correction factor of 2.4; and Padmanaban (2013) identified a correction factor of 3.1 (see Table 5).

NCSA (2023a) described how FARS data from 2017 underreported side underride crashes, with only 52 FARS cases coded as vehicle side underride crashes with 59 side underride fatalities. In contrast, this study used a larger FARS data set, from 2007 to 2020, and found an annual average of 88 FARS cases that were coded as side underride crashes with a corresponding average of 101 fatalities (i.e., 1,238/14 = 88 side underride crashes; 1,415/14=101 fatalities). Not only did NCSA (2023a) use a limited amount of FARS data to draw inferences, but the study also excluded a substantial number of fatal side underride crashes by disregarding fatal crashes with more than two vehicles and fatal crashes that did not code damage to the passenger vehicle or commercial truck. For example, this study found that from 2007 to 2020 there were 139 side underride crashes cataloged in FARS (or an estimated 246 side underride crashes using the NCSA (2023a) correction factor of 1.77 for an estimated average of 18 side underride crashes and 21 corresponding fatalities per year) involving more than 2 vehicles, which NCSA (2023a)

would have excluded from their target population. Nevertheless, all FARS cases include at least one fatality regardless of damage sustained to vehicles, indicating that NCSA (2023a) inappropriately omitted side underride crashes and corresponding fatalities from its analysis of the side underride safety problem. In fact, using the current study, NHTSA's estimated target population is based on a mere 59 and 58 percent of the side underride crash and fatality data in FARS. Specifically, NCSA (2023a) excluded 41 and 42 percent of the side underride crashes and fatalities that are cataloged in FARS, respectively $\left[\frac{1{,}238-(52\times14)}{1{,}238} = 0.41;\ \frac{1{,}415-(59\times14)}{1{,}415} = 0.42\right]$. These are all significant computational and procedural errors that should be corrected in the cost-benefit analysis (NCSA 2023a), particularly given that Executive Order 12866 (1993) requires agencies to base their decisions on the best reasonably available scientific, technical, economic, and other information on the need for, and consequences of, the intended regulation (see also USDOT 2012).

Utilizing 14 years of FARS data from 2007 to 2020 and applying NCSA's (2023a) conservative (i.e., because it is based on only 2017 data, which may not be statistically representative across years) undercount correction factor generated an estimated 2,191 side underride crashes, which resulted in 2,505 fatalities or an average of 157 side underride crashes and 179 fatalities per year (Table 5). From 2007 to 2020, there were an estimated 4,825 vehicles involved in these side underride crashes, with an average of 345 vehicles per year (Table 5). Using NCSA's (2023a) undercount correction factor, there have been an estimated 7,982 side underride crashes and 9,124 corresponding fatalities involving 17,595 vehicles in the 51 years since the USDOT (1969) first reported that, "It is anticipated that the proposed [rear impact guard] standard will be amended, after technical studies have been completed, to extend the requirement for underride protection to the sides of large vehicles."

Figure 1. Locations of side underride crashes (n=1,238) in the United States from 2007 to 2020.

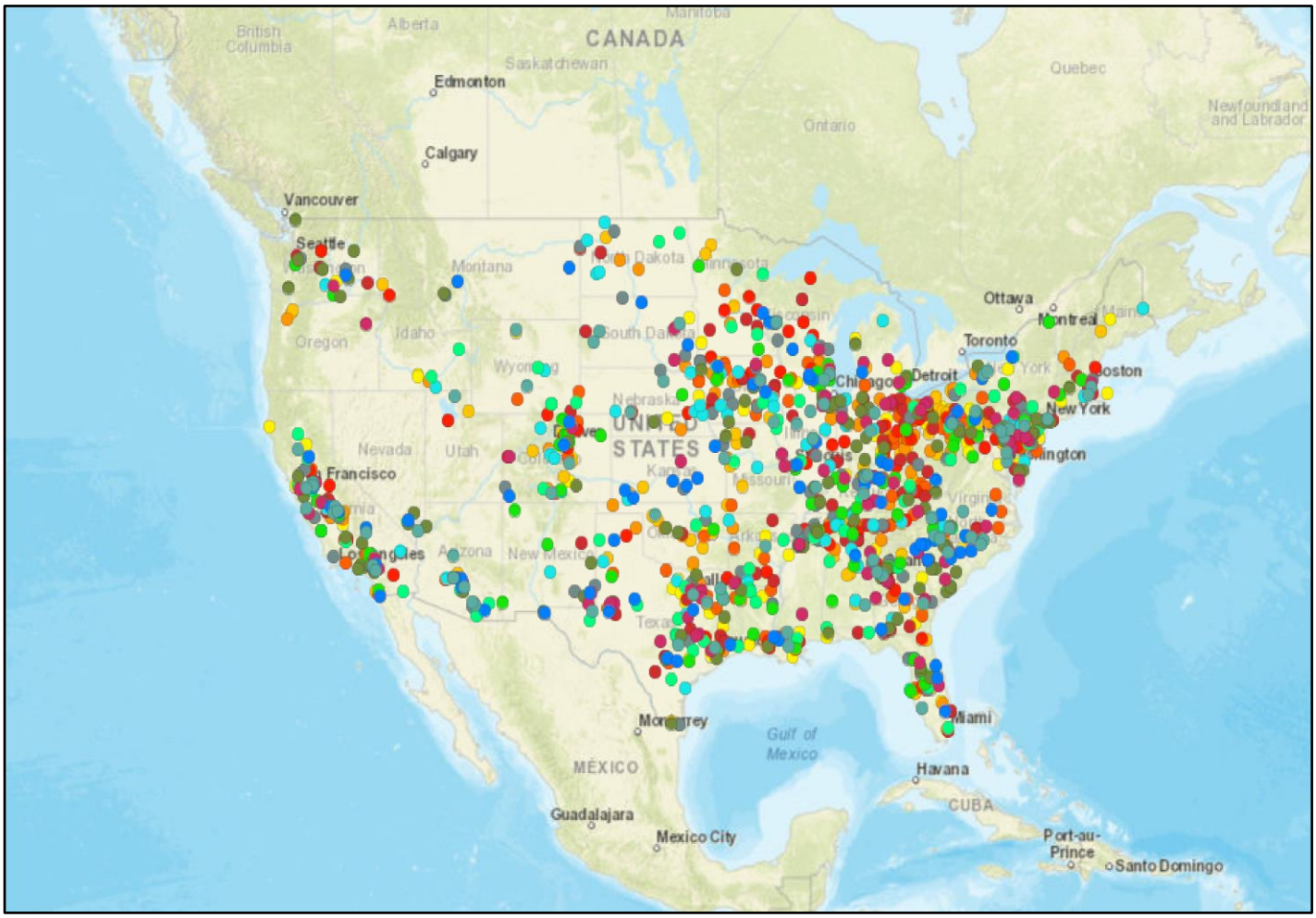

Figure 2. Locations of side underride crashes (n=110) in Texas from 2007 to 2020 that are cataloged in FARS.

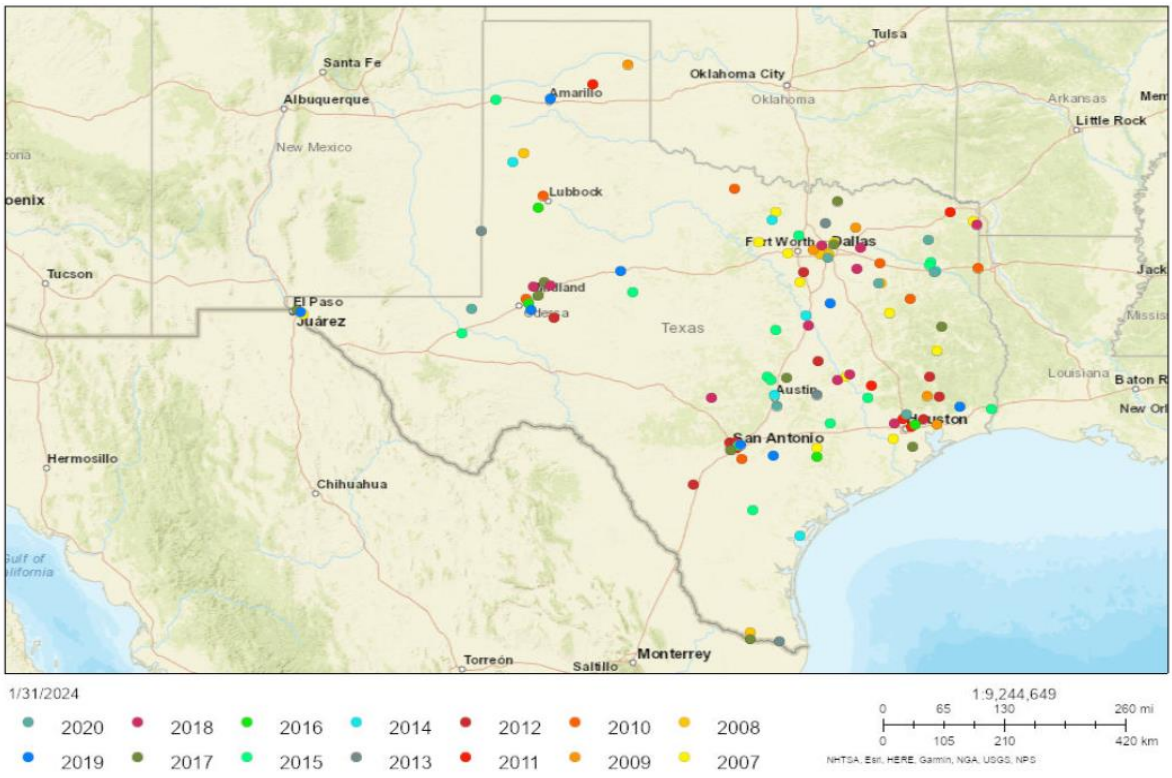

Table 1. Number of side underride crashes in the United States from 2007 to 2020 that are cataloged in FARS.

Crash Year	Crash Month												
	January	February	March	April	May	June	July	August	September	October	November	December	Total
2007	12	9	5	7	11	9	6	9	6	13	9	10	106
2008	13	5	8	6	7	7	5	10	13	12	1	7	94
2009	6	5	5	11	6	3	6	8	4	5	11	6	76
2010	9	12	7	3	4	5	6	6	4	9	12	8	85
2011	6	11	10	5	3	4	5	6	5	4	8	8	75
2012	11	14	3	10	7	7	8	13	7	7	3	11	101
2013	8	5	7	3	4	12	9	6	8	7	9	11	89
2014	12	2	4	2	3	11	8	5	6	11	7	5	76
2015	5	6	5	6	9	6	8	5	7	12	5	12	86
2016	7	6	4	6	11	5	3	13	6	10	1	8	80
2017	11	10	6	4	5	10	8	11	8	16	8	24	121
2018	8	9	7	6	4	6	10	6	5	10	8	4	83
2019	6	8	6	7	5	3	8	6	12	3	10	8	82
2020	6	6	3	5	5	6	10	10	7	11	6	9	84
Total	120	108	80	81	84	94	100	114	98	130	98	131	1,238[A]

[A] FARS cataloged 78 percent of these fatal side underride crashes (n=966) occurring on Interstates, U.S. Highways, and State Highways and not on County roads or local streets.

Filters Selected for Vehicle Involved in Side Underride Crashes:

- Involving A Large Truck:
  - Yes;
- Manner Of Collision:
  - Angle; or Sideswipe;
- Underride/Override:
  - Underriding a Motor Vehicle In-Transport, Underride, Compartment Intrusion; or
  - Underriding a Motor Vehicle In-Transport, Underride, No Compartment Intrusion; or
  - Underriding a Motor Vehicle In-Transport, Underride, Compartment Intrusion Unknown; or
  - Underriding a Motor Vehicle Not In-Transport, Underride, Compartment Intrusion; or
  - Underriding a Motor Vehicle In-Transport, Underride, No Compartment Intrusion; or
  - Underriding a Motor Vehicle In-Transport, Underride, Compartment Intrusion Unknown

Table 2. Number of fatalities from side underride crashes in the United States from 2007 to 2020 that are cataloged in FARS.

Crash Year	Crash Month												
	January	February	March	April	May	June	July	August	September	October	November	December	Total
2007	14	10	4	10	12	10	6	12	6	14	10	14	122
2008	15	5	9	6	7	7	7	10	17	17	1	9	110
2009	7	5	5	11	7	4	7	13	4	5	14	6	88
2010	9	11	8	3	4	5	7	6	5	10	11	10	89
2011	7	11	12	5	3	6	5	6	5	4	9	9	82
2012	12	17	8	10	8	9	10	15	7	8	3	10	117
2013	9	6	7	3	6	12	9	8	10	8	11	11	100
2014	16	3	6	2	4	21	8	5	7	11	12	7	102
2015	6	7	5	6	9	6	5	5	9	12	7	12	89
2016	7	6	4	6	15	5	4	15	7	11	1	11	92
2017	10	12	6	8	6	11	8	19	9	16	9	26	140
2018	8	10	9	8	4	7	10	6	6	12	9	4	93
2019	6	10	9	7	5	4	10	6	14	4	11	8	94
2020	7	6	3	6	6	7	14	10	6	14	6	12	97
Total	133	119	95	91	96	114	110	136	112	146	114	149	1,415

Table 3. Number of vehicles involved in side underride crashes in the United States from 2007 to 2020 that are cataloged in FARS.

Crash Year	Crash Month												
	January	February	March	April	May	June	July	August	September	October	November	December	Total
2007	27	19	8	15	25	21	12	18	12	29	21	20	227
2008	31	10	17	13	16	14	13	24	29	25	2	14	208
2009	12	11	10	24	13	7	19	16	9	10	26	13	170
2010	20	24	17	6	9	8	14	12	8	19	24	16	177
2011	12	22	21	12	6	8	12	16	12	8	16	17	162
2012	23	39	6	21	19	15	18	28	14	16	7	21	227
2013	18	10	15	6	11	24	16	12	17	17	19	36	201
2014	62	4	12	4	6	28	16	10	12	22	15	10	201
2015	10	30	12	26	19	12	11	11	16	24	10	25	206
2016	15	13	8	12	27	10	6	29	13	23	2	21	179
2017	26	21	13	9	15	20	20	22	17	31	17	50	261
2018	16	8	14	12	8	12	22	9	10	21	18	9	159
2019	14	16	12	14	10	6	16	12	27	6	20	16	169
2020	12	12	6	10	12	13	22	20	12	24	15	21	179
Total	298	239	171	184	196	198	217	239	208	275	212	289	2,726

Table 4. Number of side underride crashes and associated fatalities from each State that are cataloged in FARS from 2007 to 2020 and their corresponding estimates using NCSA's (2023a) undercount correction factor, in addition to the number of vehicles involved in side underride crashes, the number of crashes involving greater than two vehicles, and the trafficway class of each crash.

State	Number of Side Underride Crashes	Number of Side Underride Fatalities	Number of Vehicles Involved in Side Underride Crashes	Estimated Number of Side Underride Crashes [A]	Estimated Number of Side Underride Fatalities [B]	Number of crashes involving greater than 2 vehicles	Interstate, US Highway, or State Highway
Alabama	19	20	39	34	35	1	13
Alaska	2	2	2	4	4	0	0
Arizona	26	31	59	46	55	4	11
Arkansas	18	19	37	32	34	1	18
California	105	130	222	186	230	7	47
Colorado	43	48	101	76	85	8	35
Connecticut	3	3	6	5	5	0	2
Delaware	4	4	8	7	7	0	4
District of Columbia	0	0	0	0	0	0	0
Florida	39	43	82	69	76	2	31
Georgia	50	63	104	89	112	3	43
Hawaii	0	0	0	0	0	0	0
Idaho	8	8	17	14	14	1	6
Illinois	41	47	91	73	83	7	31
Indiana	30	36	67	53	64	8	28
Iowa	62	71	141	110	126	5	48
Kansas	12	15	24	21	27	0	10
Kentucky	46	47	101	81	83	8	43
Louisiana	30	33	60	53	58	0	27

State	Number of Side Underride Crashes	Number of Side Underride Fatalities	Number of Vehicles Involved in Side Underride Crashes	Estimated Number of Side Underride Crashes [A]	Estimated Number of Side Underride Fatalities [B]	Number of crashes involving greater than 2 vehicles	Interstate, US Highway, or State Highway
Maine	3	3	6	5	5	0	3
Maryland	8	8	16	14	14	0	6
Massachusetts	11	11	24	19	19	2	9
Michigan	15	17	32	27	30	1	10
Minnesota	16	19	32	28	34	0	7
Mississippi	2	2	4	4	4	0	2
Missouri	17	20	36	30	35	1	15
Montana	5	5	10	9	9	0	5
Nebraska	14	16	29	25	28	1	14
Nevada	4	4	8	7	7	0	4
New Hampshire	1	1	3	2	2	1	1
New Jersey	19	21	59	34	37	3	14
New Mexico	12	15	25	21	27	1	12
New York	18	22	39	32	39	3	11
North Carolina	33	39	66	58	69	0	23
North Dakota	12	12	24	21	21	0	9
Ohio	85	93	194	150	165	14	73
Oklahoma	21	25	47	37	44	4	18
Oregon	4	6	8	7	11	0	4
Pennsylvania	99	102	244	175	181	22	97
Puerto Rico	0	0	0	0	0	0	0
Rhode Island	1	1	2	2	2	0	1

State	Number of Side Underride Crashes	Number of Side Underride Fatalities	Number of Vehicles Involved in Side Underride Crashes	Estimated Number of Side Underride Crashes [A]	Estimated Number of Side Underride Fatalities [B]	Number of crashes involving greater than 2 vehicles	Interstate, US Highway, or State Highway
South Carolina	18	19	38	32	34	2	17
South Dakota	13	15	28	23	27	1	12
Tennessee	63	77	138	112	136	7	58
Texas	110	134	237	195	237	12	70
Utah	3	4	6	5	7	0	3
Vermont	2	2	5	4	4	1	2
Virginia	7	7	14	12	12	0	5
Washington	20	21	42	35	37	2	13
West Virginia	17	20	37	30	35	3	15
Wisconsin	35	39	71	62	69	1	25
Wyoming	12	15	41	21	27	2	11
Total	1,238	1,415	2,726	2,191	2,505	139	966

[A] Estimated number of side underride crashes is calculated by multiplying the number of side underride crashes cataloged in FARS from 2007 to 2020 by the NCSA's (2023a) undercount correction factor; 1,238*1.77=2,191.
[B] Estimated number of side underride fatalities is calculated by multiplying the number of side underride fatalities cataloged in FARS from 2007 to 2020 by the NCSA's (2023a) undercount correction factor; 1,415*1.77=2,505.

Table 5. Estimated number of crashes, associated fatalities, and vehicles involved in side underride collisions in the United States from 2007 to 2020 using cataloged FARS underride data multiplied by undercount correction factors.

Source	Undercount Factor	Estimated Number of Side Underride Crashes	Estimated Number of Side Underride Fatalities	Estimated Number of Vehicles Involved in Side Underride Crashes	Average Estimated Number of Side Underride Crashes/Fatalities/Vehicles Per Year
NHTSA (2023a)	1.77	2,191[A]	2,505[B]	4,825[C]	157 [D]/179/345
Hein (2023)	2.4	2,971	3,396	6,442	212/243/467
Padmanaban (2013)	3.1	3,838	4,387	8,451	274/313/604

[A] Example Calculation: number of cataloged side underride crashes multiplied by undercount correction factor: 1,238*1.77=2,191
[B] Example Calculation: number of cataloged side underride fatalities multiplied by undercount correction factor: 1,415*1.77=2,505
[C] Example Calculation: number of cataloged vehicles involved in side underride crashes multiplied by undercount correction factor: 2,726*1.77=4,825
[D] Example Calculation: average estimated number of side underride fatalities multiplied by undercount correction factor: 2,191÷14=157

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