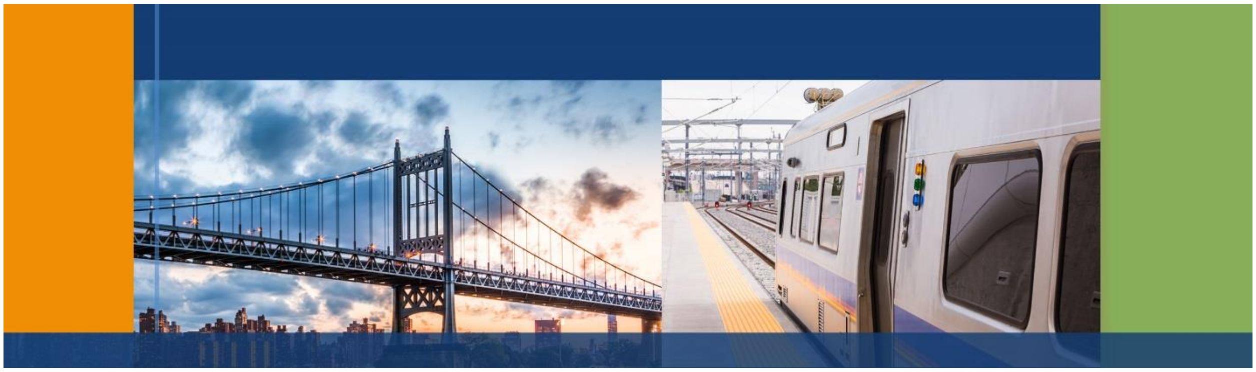


CHAPTER 5: Safety

Safety – Highways

Safety is the U.S. Department of Transportation's (DOT's) top priority. Three operating administrations within DOT have specific responsibilities for addressing highway safety:

- The Federal Highway Administration (FHWA) focuses on infrastructure safety design and operations.
- The National Highway Traffic Safety Administration (NHTSA) oversees vehicle safety standards and administers driver behavior programs.
- The Federal Motor Carrier Safety Administration (FMCSA) works to reduce crashes, injuries, and fatalities involving large trucks and buses.

These coordinated efforts, coupled with a comprehensive focus on shared, reliable safety data, enables these three DOT administrations to concentrate on their areas of expertise and responsibility while working toward the Nation's safety goals and encourages a more unified endeavor.

KEY TAKEAWAYS

- DOT's top priority is to make the U.S. transportation system the safest in the world.
- Great progress has been made in reducing overall roadway-related fatalities and injuries despite increases in population and travel. From 2006 to 2016, highway fatalities have decreased by nearly 12 percent.
- The fatality rate per 100 million VMT dropped from 1.42 in 2006 to 1.18 in 2016.
- From 2009 to 2016, fatalities involving pedestrians, bicyclists, and other nonmotorists have increased 44 percent, up to over 7,000 in 2016. This is following a decline that occurred from 2006 to 2009.
- As DOT moves toward the vision of zero deaths and injuries on our Nation's roadways, improvements in data, better safety analysis tools, and implementation of legislative mandates will be essential.

This chapter provides data on highway crashes, fatalities and injuries as well as information on FHWA safety programs. FHWA provides technical assistance and expertise to Federal, State, Tribal, and local governments for researching, designing, and implementing safety improvements for roadway infrastructure. FHWA supports improvements in safety elements as part of all road and bridge construction and system preservation projects. The Highway Safety Improvement Program (HSIP) is FHWA's primary infrastructure safety funding program. HSIP uses a performance-driven, strategic approach to achieve significant reductions in fatalities and serious injuries on all public roads for all road users, including pedestrians and bicyclists. The HSIP also helps States improve their roadway safety data. Additionally, the HSIP supports railway-highway grade crossing safety through set-aside funding. Use of HSIP funds is driven by a statewide coordinated plan, developed in cooperation with a broad range of multidisciplinary stakeholders, which provides a comprehensive framework for safety. This data-driven State Strategic Highway Safety Plan (SHSP) defines State safety goals and integrates the four "E's"—engineering, education, enforcement, and emergency services. The SHSP guides States and their collection of data in the use of HSIP and other funds to resolve safety problems and save lives.

Highway Fatalities and Injuries

Statistics discussed in this section are drawn primarily from the Fatality Analysis Reporting System (FARS). FARS is a nationwide census of fatal crashes that provides DOT, Congress, and the American public with data regarding fatal motor vehicle traffic crashes. NHTSA, which has a cooperative agreement with States to provide information on fatal crashes, maintains FARS. FARS data are combined with exposure data from other sources to produce fatal crash rates. The most frequently used exposure data are estimates of vehicle miles traveled (VMT) that FHWA collects through the Highway Performance Monitoring System (HPMS). (See Chapter 1.)

In addition to FARS, NHTSA estimates injuries nationally through the Crash Report Sampling System (CRSS). The CRSS dataset provides a statistically based annual estimate of total nonfatal injury crashes. It is important to note that nonfatal safety statistics in this section, compiled in early 2018 using CRSS data through 2015, represent a "snapshot in time" during the preparation of this report. As a result, some statistics might not precisely correspond to those in other, more recently compiled data and reports.

CRSS builds on the retiring, long-running National Automotive Sampling System General Estimates System (NASS GES). CRSS is a sample of police-reported motor vehicle traffic crashes involving all types of motor vehicles, pedestrians, and cyclists, ranging from property-damage-only crashes to those that result in fatalities. The target population of the CRSS is all police-reported traffic crashes of motor vehicles (motorcycles, passenger cars, SUVs, vans, light trucks, medium- or heavy-duty trucks, buses, etc.). The CRSS target population is the same as the previous NASS GES target population.

In 2016, 34,439 fatal crashes (see *Exhibit 5-1*) occurred on our Nation's roadways, resulting in 37,461 fatalities (see *Exhibit 5-2*). In 2015, 6.1 million motor vehicle crashes on our Nation's roadways were reported to police. The crashes ranged in severity, as shown in *Exhibit 5-1*. Of those crashes in 2015, 32,539 involved at least one fatality, approximately 1.6 million crashes resulted in injuries that were not life-threatening, and 4.5 million crashes resulted in damage or harm to property alone. From 2006 to 2016, fatal crashes decreased by 15.8 percent. From 2006 to 2015, injury crashes decreased by 5.8 percent, and property-damage-only crashes increased by 11.4 percent.

Traffic Fatality Trends Since 2016

Although this report focuses primarily on data through 2016, more recent data show that 36,560 people died in crashes on U.S. roadways during 2018, a 2.4-percent decrease from the 37,473 people killed in 2017 and a 3.3-percent decrease from the 37,806 people killed in 2016. The fatality rate per 100 million VMT decreased from 1.19 in 2016 to 1.17 in 2017 and to 1.13 in 2018. The number of urban fatalities was larger than the number of rural fatalities in 2016, 2017, and 2018. In 2017 and earlier, rural fatalities were larger than urban fatalities.

From 2017 to 2018, the number of passenger vehicle (including passenger cars and light trucks) occupant fatalities decreased from 23,663 in 2017 to 22,697 in 2018, a 4.1-percent decrease. Motorcyclist fatalities decreased from 5,229 in 2017 to 4,985 in 2018 (a 4.7-percent decrease). Large truck occupant fatalities increased from 878 in 2017 to 885 in 2018 (a 0.8-percent increase). Pedestrian fatalities increased from 6,075 to 6,283 (a 3.4-percent increase). Pedalcyclist fatalities increased from 806 to 857 (a 6.3-percent increase).

The share of total crashes related to roadway departure rose from 48 percent in 2016 to 51 percent in 2018. The share of total crashes relating to intersections held roughly constant at 27 percent over this period.

The above figures come from the 2018 FARS Annual Report File and the 2017 FARS Final File, both released in October 2019, as well as the 2016 FARS Final File released in October 2018. All other 2016 FARS data in the chapter are derived from the FARS 2016 ARF File, which was released in 2017. The FARS 2016 ARF File included a preliminary figure of 37,461 fatalities for 2016; this figure was adjusted upward to 37,806 in the 2016 FARS Final File.

Exhibit 5-2 displays trends in motor vehicle fatality counts and fatality rates from 1980 to 2016, as well as injury counts, and injury rates from 1980 to 2016. The motor vehicle fatality count rose to above 51,000 in 1980 and then dropped to less than 44,000 in 1982. The fatality count declined following the recession in the early 1990s from 44,599 in 1990 to less than 39,250 in 1992 but remained above 40,000 every year from 1993 through 2007. Between 2007 and 2009, there was an overall 17.9-percent reduction in fatalities, coinciding with the 2008–2009 economic recession. An 8.4-percent increase in fatalities occurred in 2015, and a 5.6-percent increase occurred in 2016. In addition to the fatality counts shown in *Exhibit 5-2*, fatality rates are shown for two different measures of exposure: rates expressed in terms of population and rates in terms of VMT. Fatality rate per 100 million VMT provides a metric that enables transportation professionals to consider fatalities in terms of the additional exposure associated with driving more miles. The fatality rates per 100,000 population shown in *Exhibit 5-2* express exposure in terms of people's likelihood of being killed in a motor vehicle crash, regardless of the amount of highway travel. Such data are also often stratified to examine in more depth how different demographic groups, such as male drivers aged 16–20 vs. male drivers aged 21–44, experience different fatality rates.

Exhibit 5-1 ■ Crashes by Severity, 2006–2016

	Crash Severity							
	Fatal		Injury		Property Damage Only		Total Crashes	
Year	Number	Percent	Number	Percent	Number	Percent	Number	Percent
2006	38,648	0.7	1,677,165	29.3	4,007,220	70.0	**5,723,033**	**100.0**
2007	37,435	0.6	1,651,565	28.6	4,076,939	70.7	**5,765,939**	**100.0**
2008	34,172	0.6	1,573,910	28.3	3,953,040	71.1	**5,561,122**	**100.0**
2009	30,862	0.6	1,460,500	27.7	3,782,288	71.7	**5,273,650**	**100.0**
2010	30,296	0.6	1,452,378	27.9	3,724,801	71.5	**5,207,475**	**100.0**
2011	29,867	0.6	1,426,592	27.8	3,669,122	71.6	**5,125,581**	**100.0**
2012	31,006	0.6	1,511,184	28.0	3,860,976	71.5	**5,403,166**	**100.0**
2013	30,203	0.6	1,470,861	26.9	3,973,629	72.6	**5,474,693**	**100.0**
2014	30,056	0.5	1,515,893	26.0	4,282,261	73.5	**5,828,210**	**100.0**
2015	32,539	0.5	1,579,226	26.0	4,465,324	73.5	**6,077,089**	**100.0**
2016	34,439	0.5	2,116,000	31.0	4,670,000	68.5	**6,821,000**	**100.0**

Source: Fatality Analysis Reporting System and National Automotive Sampling System General Estimates System, National Center for Statistics and Analysis, NHTSA.

The fatality rate per 100,000 population was 22.48 in 1980. This rate dropped to 17.88 in 1990 and to 14.90 in 2000. The rate dropped significantly from 14.68 in 2005 to 10.69 in 2010, then remained steady until 2014, and it increased 7.5 percent from 2014 to 2015.

The fatality rate, expressed in terms of 100 million VMT, has remained less than 2.00 since 1992 and declined smoothly from 1992 through 2004. From 2005 to 2010, the rate dropped significantly from 1.46 to 1.11 and varied little from 2010 through 2014. In 2015 and 2016, the rate increased in back-to-back years, from 1.08 in 2014 to 1.15 in 2015 and 1.18 in 2016 (*Exhibit 5-2*).

Also shown in *Exhibit 5-2* are the national estimates for people nonfatally injured in motor vehicle crashes from 1988 through 2016. A historic low of 2,061,000 injured was reached in 2011 with an injury rate of 70 per 100 million VMT. Since 2011, the injury count rose 9.6 percent to 2,258,000 in 2015, and the rate rose slightly to 73 per 100 million VMT.

Trends in Nonfatal Statistics Since 2015

Estimates of nonfatal crashes for the year 2016 were not yet available in the CRSS at the time this section was originally prepared. Based on more recent data compiled in early 2020, estimated total crashes decreased from 6.8 million in 2016 to 6.7 million in 2018. Over this two-year period, crashes involving property damage only rose from 4.7 million to 4.8 million, whereas those resulting in injuries decreased from 2.1 million to 1.9 million. The estimated number of people injured in these crashes decreased from 3.1 million to 2.7 million. The estimated number of crashes involving injuries—and the number of injuries resulting from these crashes—both increased sharply from 2015 to 2016, but this may be attributable in part to improved reporting and estimation procedures.

Safety Innovations

The overall decline in roadway fatalities over the past decade may be attributable to a variety of factors, including advances in vehicle crash avoidance and occupant protection; demographic and behavioral changes; and highway infrastructure improvements. DOT-related developments over this time have included an increase in the HSIP spending rate and roadway safety infrastructure improvements such as median barriers, rumble strips, roundabouts, SafetyEdge^{SM}, Innovative Intersection and Interchange Geometrics, High Friction Surface Treatments, the use of data and analytical tools, increased seat belt use, more side air bags, and electronic stability control in vehicles.

Exhibit 5-2 ■ Summary of Fatality and Injury Rates, 1980–2016

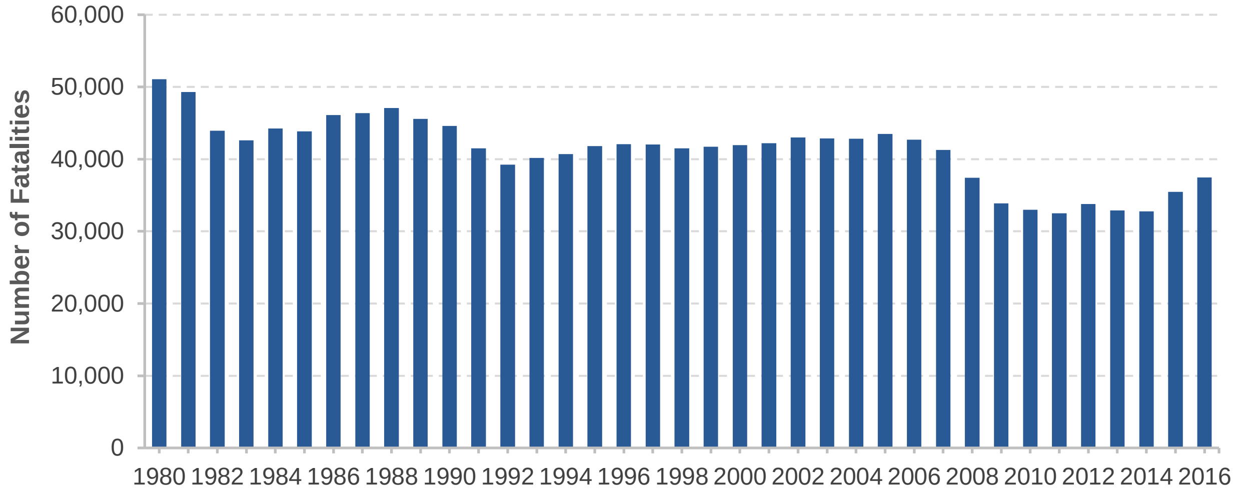
Year	Fatalities	Resident Population (Thousands)	Fatality Rate per 100,000 Population	Vehicle Miles Traveled (Millions)	Fatality Rate per 100 Million VMT	Injured	Injury Rate per 100,000 Population	Injury Rate per 100 Million VMT
1980	51,091	227,225	22.48	1,525,104	3.35			
1982	43,945	231,664	18.97	1,595,010	2.76			
1984	44,257	235,825	18.77	1,722,062	2.57			
1986	46,087	240,133	19.19	1,836,135	2.51			
1988	47,087	244,499	19.26	2,029,612	2.32	3,416,000	1,397	168
1990	44,599	249,439	17.88	2,144,183	2.08	3,231,000	1,295	151
1992[1]	39,250	254,995	15.39	2,242,857	1.75	3,070,000	1,204	137
1994	40,716	260,327	15.64	2,353,526	1.73	3,266,000	1,255	139
1996	42,065	265,229	15.86	2,482,202	1.69	3,483,000	1,313	140
1998	41,501	270,248	15.36	2,628,148	1.58	3,192,000	1,181	121
2000	41,945	281,422	14.90	2,749,803	1.53	3,077,000	1,093	112
2002	43,005	288,369	14.91	2,855,756	1.51	2,813,000	975	99
2003	42,884	290,810	14.75	2,890,893	1.48	2,776,000	955	96
2004	42,836	293,655	14.59	2,962,513	1.45	2,652,000	903	90
2005	43,510	296,410	14.68	2,989,807	1.46	2,579,000	870	86
2006	42,708	299,398	14.26	3,014,116	1.42	2,453,000	819	81
2007	41,259	301,621	13.68	3,029,822	1.36	2,381,000	789	79
2008	37,423	304,060	12.31	2,973,509	1.26	2,250,000	740	76
2009	33,883	307,007	11.04	2,953,501	1.15	2,117,000	690	72
2010	32,999	308,746	10.69	2,967,266	1.11	2,105,000	682	71
2011	32,479	311,592	10.42	2,950,402	1.10	2,061,000	661	70
2012	33,782	313,914	10.76	2,968,815	1.14	2,157,000	687	73
2013	32,894	316,129	10.41	2,988,323	1.10	2,110,000	667	71
2014	32,744	318,857	10.27	3,025,656	1.08	2,154,000	676	71
2015	35,485	321,419	11.04	3,095,373	1.15	2,258,000	703	73
2016	37,461	323,071	11.70	3,174,408	1.18	3,062,000	948	96

[1] Fatalities subsequently rose to 40,150 in 1993.

Sources: Fatality Analysis Reporting System and National Automotive Sampling System General Estimates System, National Center for Statistics and Analysis, NHTSA; U.S. Census Bureau for resident population data.

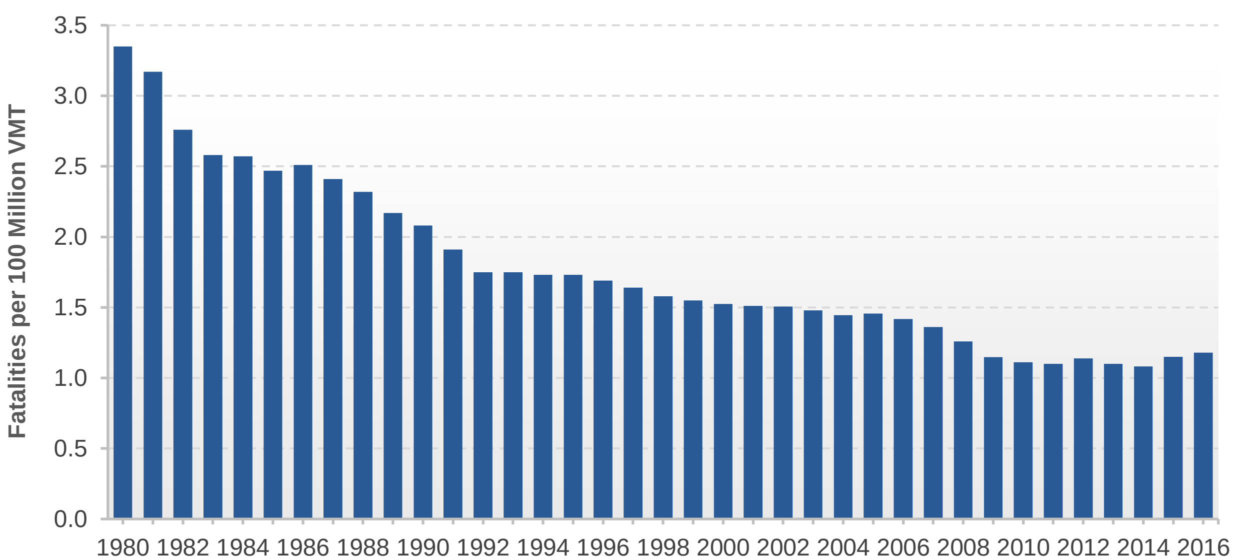
The trends since 1980 of the fatality counts and fatality rates per 100 million VMT, as discussed above and shown in *Exhibit 5-2*, are displayed graphically in *Exhibits 5-3* and *5-4*. *Exhibit 5-3* shows the number of motor vehicle fatalities from 1980 to 2016. *Exhibit 5-4* shows the motor vehicle fatality rates per 100 million VMT from 1980 to 2016.

Exhibit 5-3 ■ Fatalities, 1980–2016



Source: Fatality Analysis Reporting System and National Center for Statistics and Analysis, NHTSA.

Exhibit 5-4 ■ Fatality Rates per 100 Million VMT, 1980–2016



Source: Fatality Analysis Reporting System, National Center for Statistics and Analysis, NHTSA.

Fatalities by Roadway Functional System

The previous section presents overall counts and rates for both fatalities and injuries. This section focuses on how fatality counts and fatality rates differ between rural and urban roadway functional systems. *Exhibit 5-5* displays fatality counts and *Exhibit 5-6* displays fatality rates for 2006 through 2016. In 2016, rural roads accounted for 29.8 percent of travel and 48.5 percent of roadway fatalities, whereas urban roads accounted for 70.2 percent of travel and 51.2 percent of roadway fatalities, with 0.3 percent of roadway fatalities being "unknown rural or urban." From 2006 to 2016, the number of fatalities on rural roads decreased from 23,646 to 18,321, resulting in a 22.5-percent reduction. Over the same period, the number of fatalities on urban roads rose from 18,791 to 19,357, a 3.0-percent increase.

Exhibit 5-5 ■ Fatalities by Functional System, 2006–2016

Functional System	2006	2008	2010	2012	2014	2016	Percent Change 2006 to 2016
Rural Areas (under 5,000 in population)							
Interstate	2,887	2,422	2,113	1,835	1,762	2,282	-21.0%
Other Principal Arterial	4,554	4,395	3,986	4,219	4,044	5,496	20.7%
Minor Arterial	4,346	3,507	3,015	3,482	3,316	3,391	-22.0%
Collector	7,325	6,505	5,314	5,178	4,502	4,789	-34.6%
Local	4,294	4,060	3,540	3,452	3,024	2,336	-45.6%
Unknown Rural	240	98	121	201	143	27	-88.8%
Subtotal Rural	23,646	20,987	18,089	18,367	16,791	18,321	-22.5%
Urban Areas (5,000 or more in population)							
Interstate	2,663	2,300	2,124	2,150	2,332	2,799	5.1%
Other Freeway and Expressway	1,690	1,538	1,232	1,150	1,125	1,114	-34.1%
Other Principal Arterial	5,447	4,504	4,294	4,538	4,951	6,624	21.6%
Minor Arterial	3,807	3,128	2,945	3,065	3,069	4,232	11.2%
Collector	1,513	1,256	1,069	1,236	1,219	2,267	49.8%
Local	3,622	3,461	2,978	3,195	3,127	2,295	-36.6%
Unknown Urban	49	31	17	37	94	26	-46.9%
Subtotal Urban	18,791	16,218	14,659	15,371	15,917	19,357	3.0%
Unknown Rural or Urban	271	218	251	44	36	128	-52.8%
Total Highway Fatalities	**42,708**	**37,423**	**32,999**	**33,782**	**32,744**	**37,806**	**-23.3%**

Source: Fatality Analysis Reporting System, National Center for Statistics and Analysis, NHTSA.

These declines varied greatly by roadway functional system, as shown in *Exhibit 5-5*. For example, rural Interstate fatalities decreased by 21.0 percent from 2006 to 2016, whereas those on rural "Other Principal Arterial" roads increased by 20.7 percent. In urban areas, Interstate fatalities increased by 5.1 percent, whereas those on urban other freeways and expressways decreased by 34.1 percent and those on urban other principal arterials increased by 21.6 percent during the same period. The functional system category in Exhibit 5-5 "local" refers to the functional class of the roadway; in addition, the term local is also used in this chapter to refer to the ownership of locally owned roads.

Exhibit 5-6 ■ Fatality Rates by Functional System, 2006–2016

Functional System	Fatality Rate (per 100 Million VMT)						Percent Change 2006 to 2016
	2006	2008	2010	2012	2014	2016	
Rural Areas (under 5,000 in population)							
Interstate	1.12	1.00	0.86	0.75	0.76	0.92	-17.6%
Other Principal Arterial	1.96	1.98	1.77	1.89	1.88	2.45	24.9%
Minor Arterial	2.67	2.31	2.00	2.34	2.36	2.36	-11.5%
Collector	2.91	2.69	2.31	2.26	2.16	2.31	-20.8%
Local	3.22	3.08	2.67	2.65	2.40	1.83	-43.2%
Subtotal Rural	2.28	2.12	1.84	1.88	1.82	1.93	-15.5%
Urban Areas (5,000 or more in population)							
Interstate	0.56	0.48	0.44	0.44	0.45	0.50	-11.2%
Other Freeway and Expressway	0.78	0.69	0.56	0.51	0.49	0.45	-42.9%
Other Principal Arterial	1.17	0.97	0.94	0.99	1.06	1.37	17.2%
Minor Arterial	1.01	0.83	0.79	0.83	0.79	1.03	1.8%
Collector	0.87	0.72	0.59	0.69	0.59	1.01	16.4%
Local	1.36	1.28	1.09	1.16	1.06	0.75	-44.9%
Subtotal Urban	0.95	0.82	0.74	0.77	0.76	0.86	-9.0%
Total Highway Fatality Rate	**1.42**	**1.26**	**1.11**	**1.14**	**1.08**	**1.19**	**-16.5%**

Source: Fatality data from Fatality Analysis Reporting System, National Center for Statistics and Analysis, NHTSA; VMT data from Highway Performance Monitoring System.

> **Local Road Safety Plan**
>
> A local road safety plan (LRSP) provides a framework for identifying, analyzing, and prioritizing roadway safety improvements on local roads. The LRSP development process and content are tailored to local issues and needs. The process results in a prioritized list of issues, risks, actions, and improvements that can be used to reduce fatalities and serious injuries on the local road network. While local roads are less traveled than State highways, they have a much higher rate of fatal and serious injury crashes. Developing an LRSP is an effective strategy to improve local road safety for all road users and support the goals of a State's overall strategic highway safety plan. Information is available at https://safety.fhwa.dot.gov/provencountermeasures/local_road. More than 30,000 local agencies own and operate 75 percent of the Nation's roadways. Agency practitioners have varying levels of transportation safety expertise and often perform several duties in addition to those related to transportation safety. FHWA developed Road Safety 365: A Workshop for Local Governments, to help local practitioners routinely identify safety issues along their roadways and provide ideas on how to address them.

Exhibit 5-6 shows the fatality rates per 100 million VMT for rural and urban functional systems between 2006 and 2016. During that time, the fatality rate in rural areas declined by 15.5 percent, and, in urban areas, the fatality rate declined by 9.0 percent. Among urban roads, urban Interstate highways and Other Freeway and Expressway were the safest functional systems, with fatality rates of 0.50 and 0.45 respectively in 2016, whereas urban Other Principal Arterials had the highest fatality rate of 1.37. Among rural roads, Interstates had the lowest fatality rate of 0.92 in 2016, whereas all other functional systems had far higher fatality rates, as shown in *Exhibit 5-6*. From 2006 to 2016, urban local roads had the largest urban fatality rate decline with a 44.9-percent reduction followed by urban other freeways and expressways with a 42.9-percent reduction. Rural local roads had the large rural fatality rate decline (43.2-percent drop).

Despite the overall decreases in fatality rates on both urban and rural functional systems from 2006 to 2016, rural roads remain far more dangerous than urban roads, evidenced by a fatality rate that is 2.23 times higher (1.92 per 100 million VMT on rural roads compared to 0.86 on urban roads). In 2016, rural Interstates had a fatality rate that is 1.84 times higher than urban Interstates (0.92 per 100 million VMT compared with 0.50). Several factors collectively comprise the safety challenges on rural roads, including the roadway, behavioral factors, and emergency services issues. Addressing the challenges associated with non-Interstate roads can be made more difficult by the diversity of ownership: States typically maintain Interstate highways, whereas other roads are maintained by either the State or a variety of local organizations, including cities and counties.

Safety Data, Planning & Performance

The DOT strategic goal on safety is "Reduce transportation-related fatalities and serious injuries across the transportation system." FHWA coordinates with States as they develop SHSPs. As a major component and requirement of the HSIP, an SHSP is a statewide coordinated safety plan, developed by a State department of transportation in cooperation with a broad range of safety stakeholders. An SHSP reflects a State's analysis of highway safety problems, identifies a State's key safety needs, and guides decisions toward strategies and investments with the most potential to save lives and prevent injuries. The SHSP enables highway safety programs and partners in the State to work together to align goals, leverage resources, and collectively address the State's safety challenges. FHWA requires SHSPs to be updated every 5 years to ensure States use current data for problem identification and evidence-based strategies that have the most potential to save lives and prevent injuries.

Road to Zero

FHWA, NHTSA, and FMCSA are working with the National Safety Council (NSC) on a national road safety leadership initiative titled Road to Zero (RTZ). This initiative involves a national coalition of organizations and individuals with a commitment to eliminating road deaths within the next 30 years. As of February 2018, membership has grown to 460 members since the coalition's inception in 2016. RTZ is focusing on both short-term activities, including funding for innovative safety activities, and on a long-term vision for zero traffic fatalities. RTZ funded seven innovative 2017 safety grants totaling $1 million throughout the United States. The projects are intended to be a springboard for others to easily replicate for fast deployment of effective countermeasures. This effort is part of the RTZ's "pushing what works" element to get ahead of the recent uptick in traffic fatalities. The coalition is working on a future scenario document that will help to chart the course over the next 30 years to realize a roadway transportation system with zero fatalities. All activities are guided by a steering committee made up of 11 organizations representing the vehicle, the driver, and the roadway. Operational leadership is provided by NSC whereas FHWA, NHTSA, and FMCSA provide an advisory and supportive role.

To support their SHSPs, States must have a safety data system to identify problems and analyze countermeasures on all public roads; adopt strategic and performance-based goals; advance data collection, data analysis, and data integration capabilities; determine priorities for correcting the identified safety problems; and establish evaluation procedures.

During 2012, FHWA completed a roadway safety data capabilities assessment in each State. The assessment identified opportunities for improvement that the Roadway Safety Data Program has since addressed through development of guidance and informational resources and the delivery of technical assistance, webinars, and peer exchanges. FHWA conducted a second safety data capabilities assessment in each State in 2017–2018. This assessment will be useful to States as they implement and achieve performance goals.

Improved Safety Analysis Tools

FHWA provides and supports a wide range of data and safety analysis tools for State and local highway agency practitioners. These tools help practitioners understand safety problems on their roadways, link crashes to their roadway environments, and select and apply appropriate countermeasures. The tools' capabilities range from simple to complex. Some provide general information; others provide predictive capabilities of expected safety performance based on roadway geometric and traffic factors.

One valuable safety analysis tool is the Highway Safety Manual (HSM), published by AASHTO and developed through cooperative research initiated by FHWA. The document's primary focus is the introduction and development of analytical tools for predicting the impact of transportation project and program decisions on road safety. The HSM provides information and tools that facilitate roadway planning, design, operations, and maintenance decisions based on precise consideration of their safety consequences.

To support use of HSM methods, FHWA has delivered training, developed informational resources, and offered technical assistance for States and local highway agency practitioners. In addition, cooperative research initiated by FHWA has developed safety analysis tools, including the Interactive Highway Safety Design Model, the Systemic Safety Project Selection Tool, and the Crash Modification Factors Clearinghouse. These tools advance the abilities of State and local highway agencies to incorporate explicit, quantitative consideration of safety into their planning and project development decision-making.

FHWA's Role in Highway Safety Improvement

Since 2015, vehicles have traveled more than 3 billion miles annually on U.S. highways. Highway safety is affected by many factors, including highway infrastructure, vehicle characteristics, occupant behavior, traffic volume, weather, and more. FHWA exercises leadership throughout the multidisciplinary highway community to make the Nation's roadways safer for all users. FHWA has identified three focus areas with the greatest potential to reduce highway fatalities using infrastructure-oriented improvements: (1) roadway departure, (2) intersection crashes, and (3) pedestrian/bicycle crashes. These three focus areas encompass almost 90% of the traffic fatalities in the United States. Within these focus areas, FHWA promotes 20 proven safety countermeasures, such as median barriers, roadside design improvement at curves, walkways, rumble strips, and dedicated left- and right-turn lanes at intersections. The fatality rate per VMT in 2014 was the lowest since the collection of FARS fatality data began in 1975. As traffic fatalities have risen in 2015 and 2016, FHWA continues to expand the use of proven safety countermeasures and develop other methods for the improvement of highway safety.

Data Driven Safety Analysis (DDSA) uses tools to analyze crash and roadway data to predict the safety impacts of highway projects. DDSA allows agencies to target investments with more confidence and reduce severe crashes on the roadways. To date, 75 percent of states are applying DDSA in one or more of their project development processes. This effort is a result of collaborative work by AASHTO, FHWA, the Transportation Research Board and industry over the past two decades.

Legislative Elements

In 2016, FHWA published the HSIP and Safety Performance Management Measures (Safety PM) Final Rules in the *Federal Register*. The HSIP Final Rule updated the HSIP requirements under Title 23 of the Code of Federal Regulations (CFR) Part 924 to be consistent with the MAP-21 Act and the FAST Act and to clarify existing program requirements. Specifically, the HSIP Final Rule contains three major policy changes related to: (1) HSIP report content and schedule; (2) the SHSP update cycle; and (3) the subset of the Model Inventory of Roadway Elements (MIRE), also known as the MIRE fundamental data elements. Transportation Performance Management rulemakings are discussed more broadly in the Introduction to Part I.

The Safety PM Final Rule adds Part 490 to Title 23 of the CFR to implement the performance management requirements of section 150 of title 23 United States Code (U.S.C.), including the specific safety performance measure requirements for the purpose of carrying out the HSIP to assess serious injuries and fatalities on all public roads. The Safety PM Final Rule establishes five performance measures as the 5-year rolling averages for: (1) Number of Fatalities, (2) Rate of Fatalities per 100 million VMT, (3) Number of Serious Injuries, (4) Rate of Serious Injuries per 100 million VMT, and (5) Number of Nonmotorized Fatalities and Nonmotorized Serious Injuries. The Safety PM Final Rule also establishes the process for State departments of transportation and metropolitan planning organizations (MPOs) to establish and report their safety targets and the process that FHWA will use to assess whether State departments of transportation have met or made significant progress toward meeting their safety targets. In addition, the Safety PM Final Rule establishes a common national definition for serious injuries.

Together, these regulations will improve data, foster transparency and accountability, and allow safety progress to be tracked at the national level. They will inform State department of transportation and MPO planning, programming, and decision-making for the greatest possible reduction in fatalities and serious injuries.

Focused Approach to Safety

When a crash occurs, it is generally the result of many contributing factors. The roadway's design and operations, characteristics of the vehicles (fleet mix, safety features, power) and users' travel (VMT, speed, use of safety features, headway, fatigue, distraction), and interactions with non-occupants, all affect the safety of the Nation's highway system. FHWA collaborates with other agencies to understand more clearly the relationship among contributing factors and to address crosscutting ones, with a focus on infrastructure design and operation.

In 2014, FHWA reexamined crash data to identify the most common crash types relating to roadway characteristics. FHWA established three focus areas to address these factors: roadway departure, intersection, and pedestrian/bicyclist-involved crashes. These three areas were selected because they account for 87 percent of traffic fatalities and represent an opportunity to significantly reduce the number of fatalities and serious injuries. FHWA manages the Focused Approach to Safety to address the most critical safety challenges surrounding these crashes. Through this program, FHWA focuses its technical assistance and resources on States and cities with high fatality counts and fatality rates in one or more of these three categories.

In 2016, roadway departure, intersection, and pedestrian/bicyclist fatalities accounted for 48 percent, 27 percent, and 19 percent, respectively, of the 37,461 fatalities. Note that these three categories overlap, and 11 percent of fatalities involve more than one of these three focus areas. For example, when a roadway departure crash includes a pedestrian fatality, that crash would be accounted for in both the roadway departure and the pedestrian-related crash categories described in more detail below. Of the 37,461 fatalities in 2016, 13 percent do not involve a focus area.

Exhibit 5-7 shows how the number of fatalities for these crash types has changed between 2006 and 2016. During this period, roadway departure fatalities decreased by 20.2 percent, intersection-related fatalities increased by 0.5 percent, and pedestrian/bicyclist-involved fatalities increased by 22.6 percent.

Because a combination of factors can influence the fatalities shown in *Exhibit 5-7*, FHWA has developed targeted programs that include collaborative and comprehensive efforts to address all three areas. The Focused Approach to Safety program works to address the most critical safety challenges by devoting additional effort to high-priority States and targeting technical assistance and resources. More information is available at (http://safety.fhwa.dot.gov/fas/).

Exhibit 5-7 ■ Fatalities by Crash Type, 2006–2016

Crash Type	2006	2008	2010	2012	2014	2016	Percent Change 2006 to 2016
Roadway Departures[1]	22,665	19,878	17,423	17,582	16,381	18,095	-20.2%
Intersection-related[1,2]	10,213	8,956	8,636	8,851	8,692	10,267	0.5%
Pedestrian-related[1,3]	5,722	5,273	5,075	5,741	5,814	7,013	22.6%

[1] Some fatalities may overlap; for example, some intersection-related fatalities may involve pedestrians.

[2] Definition for intersection crashes was modified beginning in 2016.

[3] Definition for pedestrian crashes was modified beginning in 2016.

Source: Fatality Analysis Reporting System, National Center for Statistics and Analysis, NHTSA.

Roadway Departures

In 2016, the number of roadway departure fatalities was 18,095, which accounted for 48.3 percent of all traffic fatalities. A roadway departure crash is defined as a nonintersection crash that occurs after a vehicle crosses an edge line or a center line, or otherwise leaves the traveled way. In some cases, a vehicle crosses the center line and strikes another vehicle, hitting it head-on, or sideswiping it. In other cases, the vehicle leaves the roadway and strikes one or more constructed or natural objects, such as utility poles, embankments, guardrails, trees, or parked vehicles.

Roadway Departure Focus States and Countermeasures

Roadway Departure Focus States are eligible for additional resources and assistance. These States are selected based on an assessment of roadway departure fatalities over a 3-year period compared with expected roadway departure fatalities. The current list of Roadway Departure States includes Alabama, Arizona, Florida, Hawaii, Kentucky, Louisiana, Mississippi, South Carolina, Tennessee, Texas, and West Virginia. FHWA offers technical assistance to these States in the form of crash data analysis and implementation plan development.

Many States have developed Roadway Departure Implementation Plans, which are designed to address State-specific safety issues related to roadway departures on both State and local roadways—to the extent that relevant crash data can be obtained and are appropriate based on consultation with State and local agencies and the FHWA Division Office. The plans identify cost-effective countermeasures, deployment levels, and funding needs to reduce the number and severity of roadway departure crashes in the State by a targeted amount consistent with SHSP goals. Each plan quantifies the costs and benefits of a roadway departure-focused initiative and provides an approach for implementation. FHWA also provides outreach to these States through webinars, technical support, and training courses.

Three proven safety countermeasures for reducing roadway departure crashes are:

- Longitudinal rumble strips and stripes on two-lane rural roads: Milled or raised elements on the pavement intended to alert inattentive drivers through vibration and sound that their vehicles have left the travel lane.
- Enhanced delineation and friction for horizontal curves: Signs and pavement deployed to warn the driver in advance of the curve, with pavement friction to reduce skidding due to excessive approach speed into the curve to keep the vehicle in its lane.
- SafetyEdge^{SM}: Technology that shapes the edge of a paved roadway in a way that eliminates tire scrubbing, a phenomenon that contributes to losing control of a vehicle.

Intersections

Estimates indicate that the United States has more than 3 million intersections, most of which are nonsignalized (controlled by stop signs or yield signs, or without any traffic control devices), and a small proportion of which are signalized (controlled by traffic signals). Intersections are planned points of conflict in any roadway system. People—some in motor vehicles, others walking or biking—cross paths as they travel through, or turn from, one route to another. Areas where different paths separate, cross, or join are known as conflict points, and these are always present in intersections.

In 2016, 27 percent of fatalities were related to intersections, with 35 percent occurring in rural areas and 65 percent occurring in urban areas, as shown in *Exhibit 5-8*. From 2006 to 2016, intersection-related fatalities have increased by 0.5 percent. The geometric design of an intersection and corresponding application of traffic control devices can substantially reduce the likelihood of crashes, resulting in fewer crashes, injuries, and fatalities. Furthermore, when the speed of motor vehicles through intersections can be reduced, the severity of crashes that do occur will also be lessened.

Intersection Focus States and Countermeasures

Intersection Focus States receive additional training and technical assistance based on an assessment of intersection fatalities over a 3-year period compared with expected fatalities. The current list of Intersection Focus States includes Arizona, Florida, Louisiana, Nevada, New Jersey, New York, South Carolina, Tennessee, and Texas.

As part of the Focused Approach to Safety, FHWA works with States to advance their SHSP strategies for intersection safety. These efforts include pursuing systemic intersection safety improvements, advancing innovative intersection designs (such as roundabouts, J-turns, and diverging diamond interchanges), and encouraging the development of intersection control evaluation policies and procedures. FHWA also assists these States on timely intersection safety matters through webinars, technical support, and training courses.

Six proven countermeasures associated specifically with intersection safety are:

- Leading pedestrian interval (LPI): This gives pedestrians the opportunity to enter an intersection 3-7 seconds before vehicles are given a green indication
- Reduced left-turn conflict intersections: Geometric designs that alter how left-turn movements occur in order to simplify decisions and minimize the potential for related crashes.
- Corridor access management: A set of techniques useful for managing access to highways, major arterials, and other roadways, and that result in reduced crashes, fewer vehicle conflicts, and improved movement of traffic.
- Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections: This systemic approach to intersection safety involves deploying a group of multiple low-cost countermeasures, such as enhanced signing and pavement markings, at a large number of stop-controlled intersections within a jurisdiction. It is designed to increase driver awareness and recognition of the intersections and potential conflicts.
- Pedestrian hybrid beacons: Pedestrian-activated warning device located on the roadside or on mast arms over midblock pedestrian crossings.
- Road diets: A roadway reconfiguration that involves converting an undivided four-lane roadway into three lanes comprising two through-lanes and a center two-way left-turn lane.

Exhibit 5-8 ■ Intersection-related Fatalities by Functional System, 2016

Functional System	Fatalities	
	Count	Percent of Total
Rural Areas (under 5,000 in population)		
Principal Arterial	1,323	13.5%
Minor Arterial	795	8.1%
Collector (Major and Minor)	909	9.3%
Local	384	3.9%
Subtotal Rural	**3,411**	**34.8%**
Urban Areas (5,000 or more in population)		
Principal Arterial	3,144	32.1%
Minor Arterial	1,672	17.1%
Collector (Major and Minor)	766	7.8%
Local	801	8.2%
Subtotal Urban	**6,383**	**65.2%**
Total Highway Fatalities[1]	**9,794**	**100.0%**

[1] Total excludes 473 intersection-related fatalities not identified by functional class.

Source: Fatality Analysis Reporting System, National Center for Statistics and Analysis, NHTSA.

Pedestrians, Bicyclists, and Other Nonmotorists

In 2016, 18.7 percent of the transportation-related fatalities were nonmotorists.[21] *Exhibit 5-9* shows that in 2016, 6,000 pedestrians, 838 pedalcyclists, and 175 other nonmotorists were killed, totaling 7,013 nonmotorists fatalities.

Overall from 2006 through 2016, nonmotorist fatalities have risen by 22.6 percent. From 2006 to 2009, nonmotorist fatalities showed a steady decline of 15.0 percent, but beginning in 2009 that trend began to shift and resulted in a 44.2-percent increase up to 2016. Pedestrian fatalities rose from 4,120 in 2009 to 6,000 in 2016, an increase of 45.6 percent. Pedalcyclist fatalities rose from 630 in 2009 to 838 in 2016, an increase of 33 percent.

Pedestrian and Bicyclist Safety Focus States and Cities and Countermeasures

FHWA expanded its pedestrian focus area to include bicyclist and other nonmotorist fatalities in 2015. FHWA designates 16 Focus States and 35 Focus Cities for the pedestrian and bicycle focus area based on the number of pedestrian and bicyclist fatalities or the pedestrian and bicyclist fatality rate per population over a 3-year period. As of 2015, the current list of Focus States includes California, Arizona, New Mexico, Texas, Louisiana, Florida, Georgia, North Carolina, Tennessee, Missouri, Illinois, Indiana, Michigan, Pennsylvania, New Jersey, and New York. The 35 Focus Cities are distributed throughout those 16 Focus States, including seven in California, six in Florida, and five in Texas, as well as one or two Focus Cities in each of the remaining Focus States.

The Focused Approach to Safety has helped Focus States and Focus Cities raise awareness of pedestrian and bicyclist safety problems and generate momentum for addressing pedestrian and bicyclist issues. Focused Approach has provided courses, conference calls, web conferences, data analysis, and technical assistance for the development of State and local pedestrian and bicyclist safety action plans and implementation.

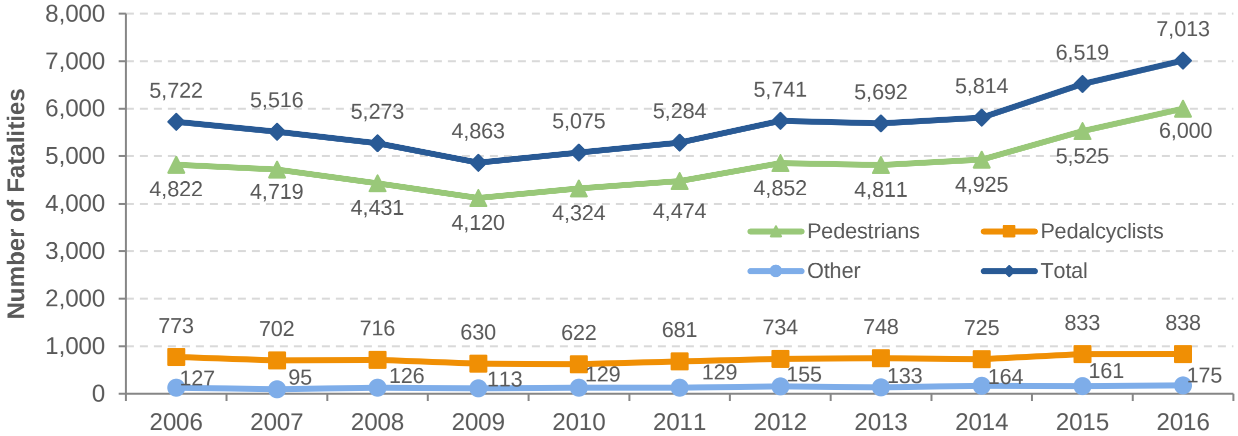
Focused Approach offers free technical support and training courses to Focus States and Focus Cities, as well as free bimonthly webinars on a comprehensive, systemic approach to preventing pedestrian and bicyclist crashes. Training is also available at a cost to non-focus States and cities through the Pedestrian and Bicycle Information Center, made possible by the National Highway Institute.

Four proven countermeasures associated specifically with pedestrian and bicyclist safety are:

- Walkways: Any type of defined space or pathway for use by a person traveling by foot or using a wheelchair. These include pedestrian walkways, shared-use paths, sidewalks, or roadway shoulders.
- Pedestrian Crossing Islands in Urban and Suburban Areas: A raised island, located between opposing traffic lanes at intersection or midblock locations, which separate crossing pedestrians from motor vehicles.
- Leading Pedestrian Interval: This gives pedestrians the opportunity to enter an intersection 3–7 seconds before vehicles are given a green indication. With this head start, pedestrians can better establish their presence in the crosswalk before vehicles have priority to turn left.
- Pedestrian hybrid beacons: These pedestrian-activated warning devices are located on the roadside or on mast arms over midblock pedestrian crossings.

[21] The term nonmotorist is defined to be those transportation system users who are not in or on traditional motor vehicles on public roadways. This includes persons traveling by foot, children in strollers, skateboarders (including motorized), roller skaters, persons on scooters, persons in wagons, persons in wheelchairs (both nonmotorized and motorized), persons riding bicycles or other pedalcycles (including those with a low-powered electric motor weighing under 100 pounds, with a top motor-powered speed not in excess of 20 mph), persons in motorized toy cars, and persons on two-wheeled, self-balancing types of devices.

Exhibit 5-9 ■ Pedestrian, Bicyclist, and Other Nonmotorist Traffic Fatalities, 2006–2016



Source: Fatality Analysis Reporting System, National Center for Statistics and Analysis, NHTSA.

In 2016, the Safety PM Final Rule established a new performance measure for the number of nonmotorized fatalities and the number of nonmotorized serious injuries. This combined measure of nonmotorized fatalities and nonmotorized serious injuries will lead to the availability of more data on nonmotorized serious injuries in the future. Additionally, the Safety PM Final Rule established a single, national definition for States to report serious injuries per the Model Minimum Uniform Crash Criteria (MMUCC) 4th Edition attribute for "Suspected Serious Injury (A)" found in the "Injury Status" element. This action will serve to standardize serious injury data to ensure a consistent, coordinated, and comparable serious injury data system that will help stakeholders at the State and national levels address highway safety challenges.

Safe Transportation for Every Pedestrian (STEP) Advances Pedestrian Hybrid Beacons (PHBs)

According to NHTSA, 2018 witnessed the most pedestrian fatalities since 1990, accounting for approximately 17 percent of all roadway fatalities (6,283). In 2018, 74 percent of pedestrian fatalities occurred away from intersections (e.g., mid-block locations) and approximately 25 percent occurred at intersections. Through the STEP initiative, FHWA will promote road diets, pedestrian refuge islands, crosswalk visibility enhancements, rectangular rapid flashing beacons, leading pedestrian intervals, and pedestrian hybrid beacons to improve pedestrian crossing locations.

The pedestrian hybrid beacon is a beneficial intermediate option between enhanced signing and a full pedestrian signal. It provides positive stop control in areas without the high pedestrian traffic volumes that typically warrant signal installation. These beacons have been proven to reduce pedestrian crashes by 55 percent, and their ability to improve crossing opportunities can boost quality of life for pedestrians of all ages and abilities. Pedestrian hybrid beacons are considered a proven safety countermeasure by FHWA.

Safety – Transit

This section summarizes national trends in safety and security incidents such as injuries, fatalities, and related performance ratios reported in the National Transit Database (NTD).

NTD compiles safety data for all transit modes, except for commuter rail systems, which the Federal Railroad Administration (FRA) manages and collects. This section presents statistics and counts of basic aggregate data, such as injuries and fatalities from NTD and FRA. For 2016, 62 rail transit systems, 639 urban fixed-route bus providers, and 372 rural agencies provided safety event data. Reported events occurred on transit property or vehicles, involved transit vehicles, or affected people using public transportation systems. Data on fatalities and fatality rates are presented following a discussion on NTD data.

Agencies operating 30 or fewer vehicles in peak service, which report to the NTD using a small systems waiver, are exempted from reporting detailed safety event data by mode and victim type. However, the total aggregate data reported by these agencies account for a very small share of the Nation's transit safety events.

KEY TAKEAWAYS

- The total number of transit fatalities in 2016 (excluding commuter rail) was 257 people, of which 13 were transit passengers.
- Transit rail fatalities increased by 53 percent from 2006 to 2016.
- A majority of transit rail fatalities occur at transit stations. In 2016, 205 people died because of collisions, accounting for 81 percent of all transit fatalities.
- Transit rail fatalities occur at a majority of transit stations. In 2016, 79 people died at transit stations, or 55 percent of all transit rail fatalities. These deaths were due primarily to suicides.
- Most bus fatalities occur on roadways at intersections. In 2016, 79 people died on roadways, or 75 percent of all fatalities.
- Together, rail modes accounted for 58 percent of noncommuter rail fatalities, and bus accounted for 42 percent. However, rail accounted for 30 percent of injuries, whereas bus accounted for 70 percent.
- There were 7,267 noncommuter rail injuries in 2016. These injuries required medical assistance at facilities away from the scenes of the accidents.
- In 2016, 97 people died in commuter rail accidents, a 42 percent increase from 2006 (68 people). The total number of fatalities in transit, including commuter rail, increased by 53 percent between 2006 and 2016, from 230 in 2006 to 353 in 2016.

Incidents, Fatalities, and Injuries, Excluding Commuter Rail

A transit agency records a safety event in the NTD for events that meet certain thresholds as described in the box below. Rural and small urban systems report only total fatalities and injuries. From 2002 to 2007, the definition of significant property damage was total property damage exceeding $7,500 (in current-year dollars, not indexed to inflation); this threshold increased to $25,000 in 2008.

Injury and fatality data in the NTD are reported by the types of people involved in incidents. Passengers are defined as individuals traveling, boarding, or alighting a transit vehicle. Patrons are individuals who are in a rail station or at a bus stop but are not necessarily boarding a transit vehicle. Employees (or workers) are individuals who work for the transit agency, including both staff and contractors (excluding construction). Public includes pedestrians, occupants of other vehicles, and other persons. Individuals who come into contact with the transit system intending to harm themselves are considered suicides. A suicide is a subset of passenger, patron, worker, trespasser, and other person types.

Any event for which an injury or fatality is reported is considered an incident. An injury is reported when a person has been transported immediately from the scene for medical care. A transit-related fatality is reported for any death occurring within 30 days of a transit incident that is confirmed to be a result of that incident. Thus, these statistics do not include fatalities resulting from medical emergencies on transit vehicles.

An incident is also recorded when property damage exceeds $25,000, regardless of whether the incident resulted in injuries or fatalities.

What Sorts of Events Result in a Recorded Transit Incident?

A transit agency records an incident for any event occurring on transit property, on board or involving transit vehicles, or to persons using the transit system, that results in one of the following:

- One or more confirmed fatalities within 30 days of the incident;
- One or more injuries requiring immediate transportation away from the scene for medical attention;
- Total property damage to transit property or private property exceeding $25,000;
- Evacuation for life safety reasons;
- Mainline derailment (that is, occurring on a revenue service line, regardless of whether the vehicle was in service or out of service); or
- Fire.

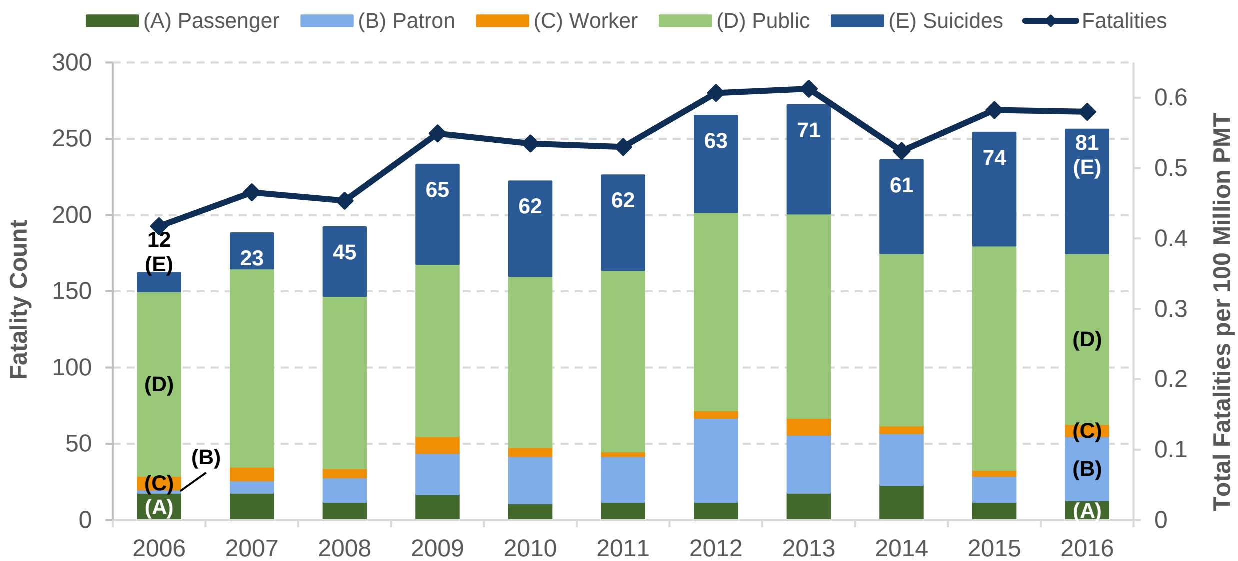
Additionally, a transit agency records an incident whenever certain security situations occur on transit property, such as:

- Robbery, burglary, or theft;
- Rape;
- Arrest or citation, such as for trespassing, vandalism, fare evasion, or assault;
- Cybersecurity incident;
- Hijacking; or
- Nonviolent civil disturbance that disrupts transit service.

Fatalities by Person Type, Event Type, and Location

Despite a decline in 2014, fatality measures have exhibited a general upward trend over the past decade. *Exhibit 5-10* shows data on fatalities, both in total fatalities and fatalities per 100 million passenger miles traveled (PMT) for FTA-oversight systems. Suicides and fatalities involving station patrons have accounted for an increasing share of transit fatalities over this period. The interactions between transit, vehicles, pedestrians, cyclists, and motorists at rail grade crossings, pedestrian crosswalks, and intersections all influence overall transit safety performance. Most fatalities and injuries result from interactions with the public on busy city streets. Suicides are also a leading cause of fatalities which have increased from 12 suicides in 2006 to 81 in 2016. Pedestrian fatalities accounted for approximately 13 percent of all transit fatalities in 2016.

Exhibit 5-10 ■ Annual Transit Fatalities, Including Suicides, 2006–2016

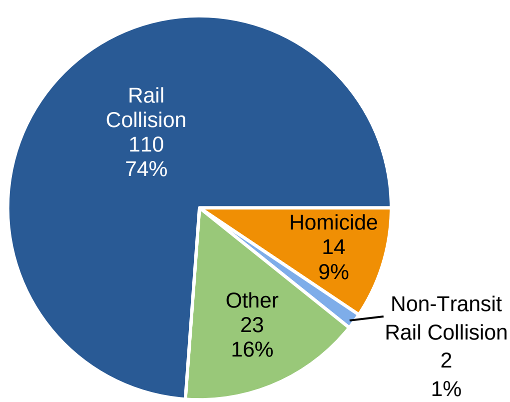


Notes: The right Y-axis displays total fatalities per 100 million passenger miles traveled (PMT) Including suicides. Fatality totals include both directly operated (DO) and purchased transportation (PT) service types.

Source: National Transit Database—Transit Safety and Security Statistics and Analysis Reporting.

Exhibits 5-11 and *5-12* depict fatalities by event type in 2016. In 2016, there were 257 transit fatalities, 108 occurring on nonrail modes and 149 on rail. Fatalities in transit are due mostly to collisions; this is the case for both rail and nonrail categories. Overall, collisions accounted for more than 80 percent of all fatalities in 2016. Collisions are primarily with vehicles at grade crossings. The number of deaths due to homicide accounted for only 8 percent of fatalities on nonrail and 9 percent on rail, mostly involving nonusers of transit.

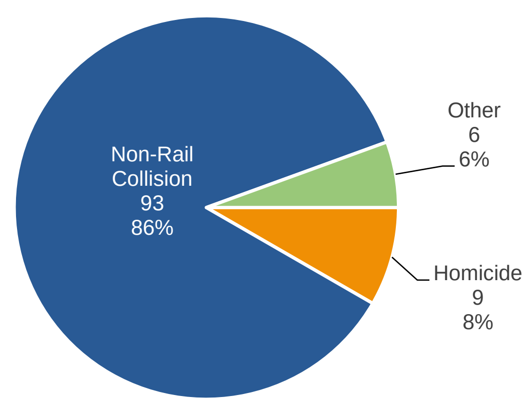
Exhibit 5-11 ■ Transit Fatality Event Types, Rail, 2016



Notes: Exhibit includes data for rail transit modes, excluding commuter rail. Two NTD event type categories were updated in 2016.

Source: National Transit Database.

Exhibit 5-12 ■ Transit Fatality Event Types, Nonrail, 2016



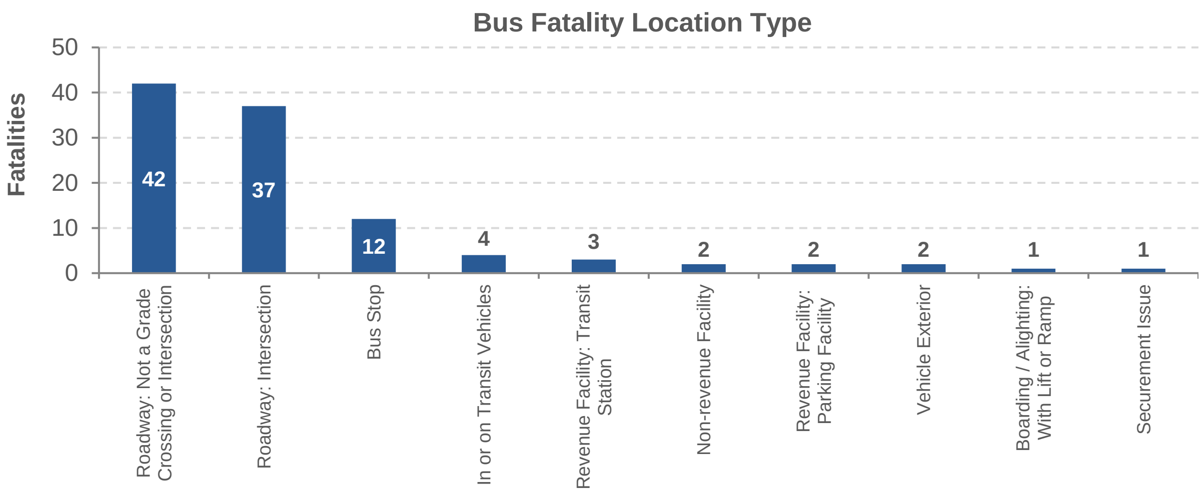
Notes: Exhibit includes data for nonrail transit modes. Two NTD event type categories were updated in 2016.

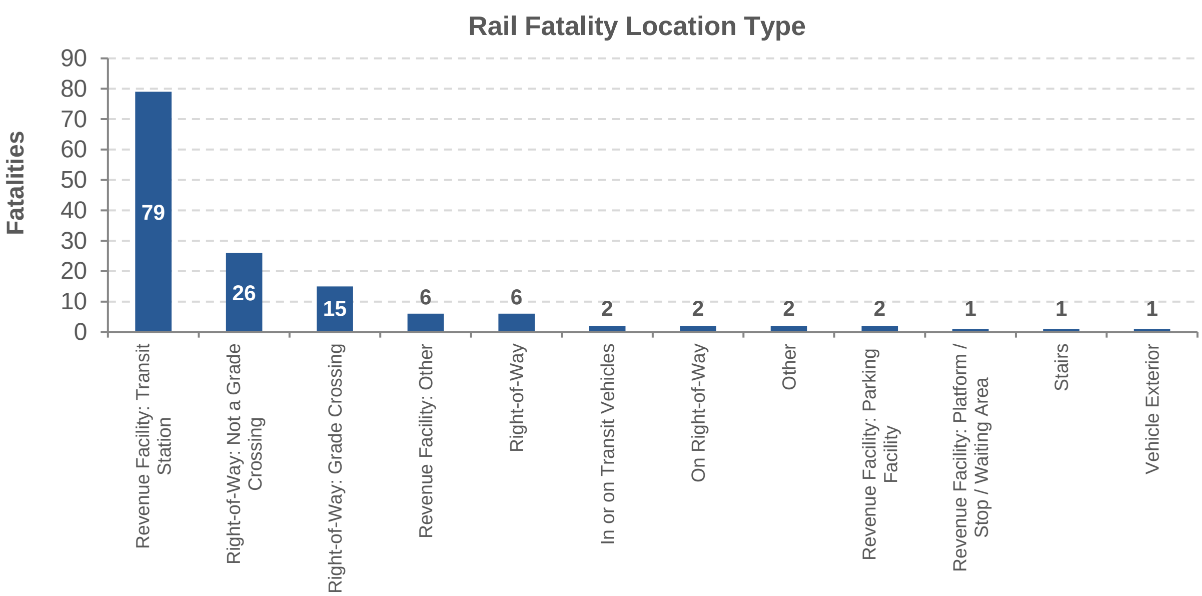
Source: National Transit Database.

Exhibit 5-13 shows fatalities by location type for bus and rail modes. Close to 75 percent of bus fatalities occur on roadways, and most victims are members of the public (not riders). In contrast, more than half of all rail fatalities occur at transit stations. In addition, 35 percent of bus fatalities occurred at roadway intersections and 10 percent of rail fatalities occurred at crossings. The interactions between transit, vehicles, pedestrians, cyclists, and motorists at rail grade crossings, pedestrian crosswalks, and intersections all influence overall transit safety performance.

In 2013, FTA, in partnership with Operation Lifesaver, made grant funds available to transit and local government agencies to develop safety education and public awareness initiatives for rail transit to ensure that people are safe near trains, tracks, and at crossings. Such awareness is increasingly important for drivers and pedestrians as rail transit expands into new communities across the country. To receive a grant, projects must provide a 25 percent match and focus on safety education or public awareness initiatives in communities with rail transit systems (commuter rail, light rail, and streetcar) using Operation Lifesaver-approved materials.[22]

Exhibit 5-13 ■ Bus and Rail Fatality Types by Location, 2016





Note: NTD event type categories were updated in 2016.

Source: National Transit Database.

[22] *2014 Annual Report: The U.S. Department of Transportation's Status of Actions Addressing the Safety Issue Areas on the National Transportation Safety Board's Most Wanted List*.

Derailments

Derailment events and level of severity are proportional to the average condition of tracks and other related asset types, combined with operating factors such as passenger car loads, speed, and frequency of service. *Exhibit 5-14* shows derailments by rail mode. Light rail is the single mode with the highest number of derailments, followed by streetcar and heavy rail. Heavy rail, which is a fast and high-capacity mode, had an average of 0.18 injuries per system. Light rail, the second fastest mode, had an average of 0.14 injuries per system; and streetcars, which operate in mixed traffic at low speeds, had only 0.13.

Cable cars are treated as a special case because they are unique, historical systems that operate in mixed traffic and are pulled by cables at low speeds. The age of these assets affects the occurrence of derailment accidents.

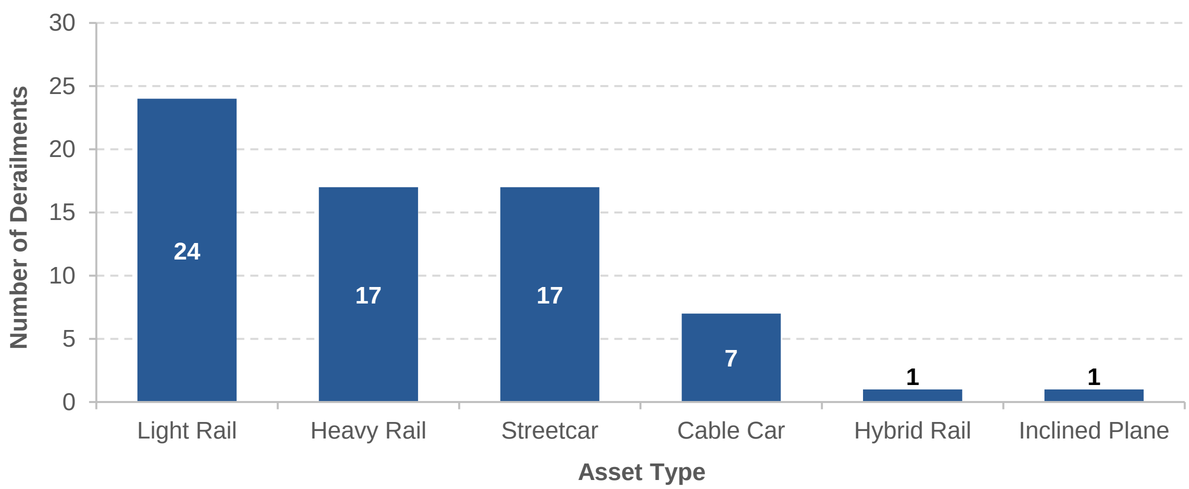
The number of derailment accidents per million vehicle revenue miles shows that heavy rail has the lowest rate, at 0.01, followed by hybrid rail and light rail.

The average cost in property damage per derailment incident is highest for heavy rail, at an average of $57,080 per accident, more than twice the same cost for light rail ($27,164) which in turn is 8 times more costly than cable car at $3,571 per accident.

Heavy rail systems are usually faster systems compared to light rail, and require very complex, diversified, and expensive asset types to operate. Heavy rail derailments are less frequent but severe when it happens in revenue service.

It should be noted that derailment events happen not only in revenue service, but also during deadhead (trips performed without accepting passengers) and maneuvers at yards and/or end stations. These incidents are usually less serious, and injure mostly employees of the agencies.

Exhibit 5-14 ■ Derailments by Rail Mode, 2014–2016



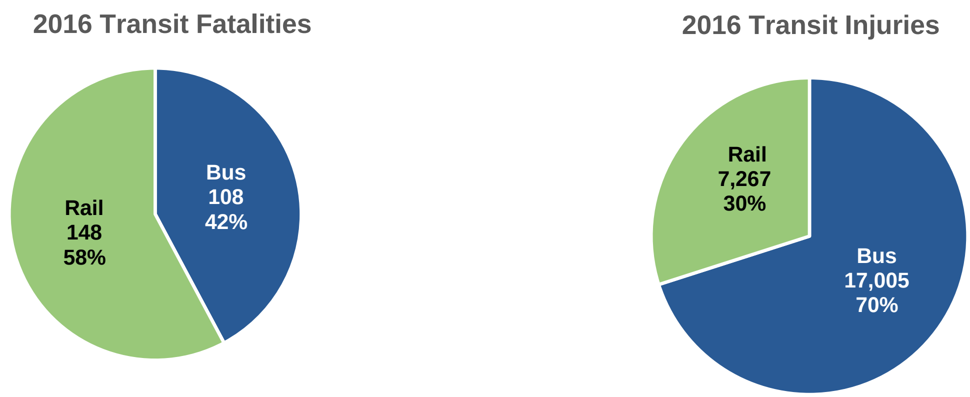
Mode	Number of Systems	Number of Derailments	Estimated Property Damage	Resulting Injuries	VRM	Derailments per Million VRM	Average Injuries per System	Property Damage per Derailment Accident
Light Rail	22	24	$651,940	3	313,838,084	0.08	0.14	$27,164
Heavy Rail	17	17	$970,363	3	1,969,675,073	0.01	0.18	$57,080
Streetcar	15	17	$23,750	2	17,355,137	0.98	0.13	$1,397
Cable Car	1	7	$25,000	2	848,353	8.25	2.00	$3,571
Hybrid Rail	7	1	$15,000	0	5,919,936	0.07	0.00	$15,000
Inclined Plane	5	1	$0	0	116,200	8.61	0.00	$0

Source: National Transit Database Safety Analysis 2014–2016.

Fatalities and Injuries by Mode

Rail accounts for a larger share of transit fatalities (58 percent), while bus accounts for a larger share of transit injuries (70 percent) as shown in *Exhibit 5-15*, which depicts the split of fatalities and injuries between rail modes and fixed-route bus. The most common type of rail accident involves people walking along sidewalks by light rail and streetcar systems. Transit passengers account for a small share of fatalities and injuries. On the other hand, common bus fatalities occur with other vehicle occupants (in collision accidents) and collisions with pedestrians near crossings.

Exhibit 5-15 ■ Transit Fatalities and Injuries by Mode, 2016



Source: National Transit Database—Transit Safety and Security Statistics and Analysis Reporting.

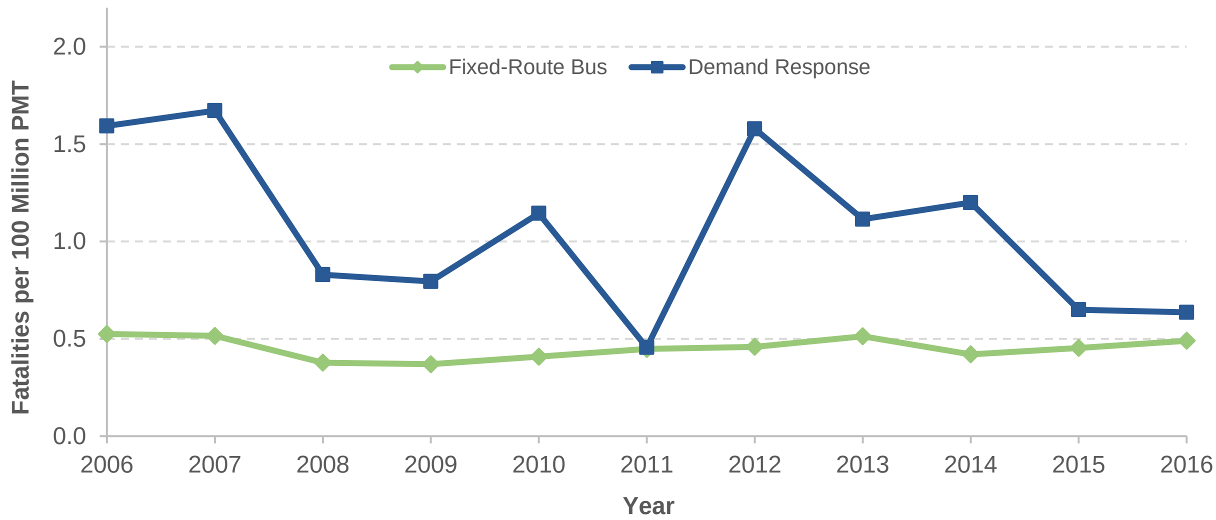
Exhibit 5-16 shows fatalities (including suicides) per 100 million PMT for fixed-route bus and demand-response transit. Note that the fatality rate for demand-response transit is more volatile than for fixed-route bus. This observation is expected, as fewer people use demand-response transit and even one or two more fatalities in a year can increase the rate significantly. Fatality rates have not changed significantly for fixed-route bus. Note that the absolute number of fatalities is not comparable across modes because of the wide range of PMT on each mode.

Exhibit 5-17 shows fatalities per 100 million PMT for heavy rail and light rail (including suicides). Heavy rail fatality rates remained relatively stable from 2008 through 2016. Suicides represent a large share of fatalities for heavy rail—approximately 57 percent in 2016. Light rail typically experiences more incidents than does heavy rail, as many systems consist of streetcars operating in mixed traffic with both automobiles and pedestrians present.

Fatality, Incident, and Injury Rates by Mode, Excluding Suicides

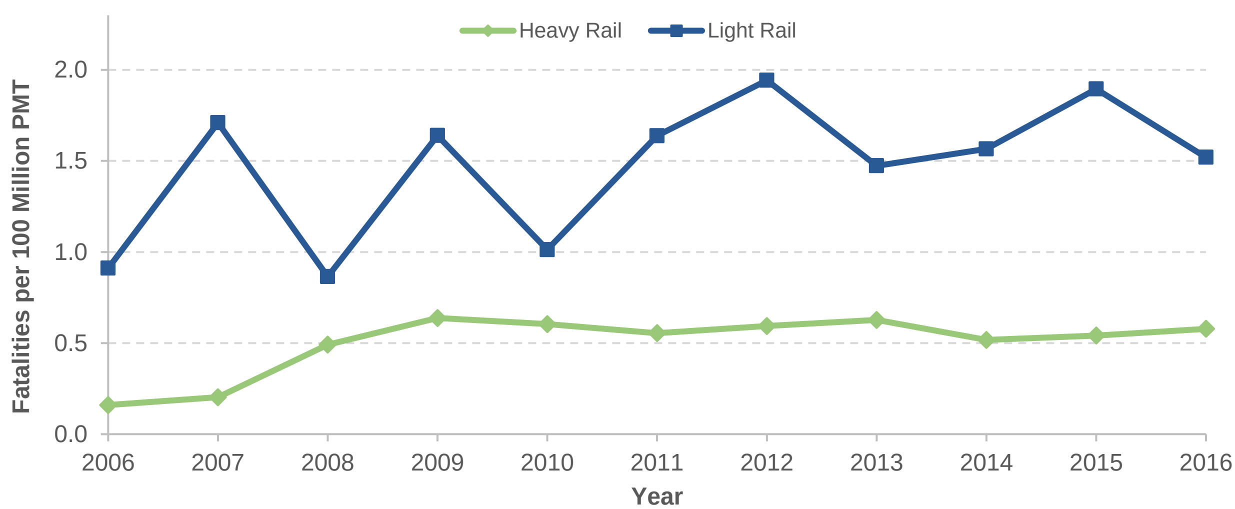
The analysis presented in *Exhibit 5-18* is by mode, which includes all major modes reported in the NTD except for commuter rail. Safety data for commuter rail are included in FRA's Rail Accident/Incident Reporting System (RAIRS). Before 2011, RAIRS did not include a separate category for suicides, which *are* reported in NTD for all modes. Therefore, for comparative purposes, suicides are excluded from this analysis.

Exhibit 5-16 ■ Annual Transit Fatality Rates by Highway Mode, 2006–2016



Note: Fatality totals include both DO and PT service types.
Source: National Transit Database.

Exhibit 5-17 ■ Annual Transit Fatality Rates by Rail Mode, 2006–2016



Note: Fatality totals include both DO and PT service types.
Source: National Transit Database.

Exhibit 5-18 shows incidents and injuries per 100 million PMT reported in the NTD for the two main highway modes in transit (fixed-route bus and demand-response transit) and the two main rail modes (heavy rail and light rail). Commuter rail is presented separately as those data were collected according to different definitions in RAIRS. With the exception of a general decline in the incident and injury measures for most modes after 2007, the data in *Exhibit 5-18* do not indicate any clear long-term trends.

Exhibit 5-18 ■ Transit Incidents and Injuries by Mode, 2006–2016

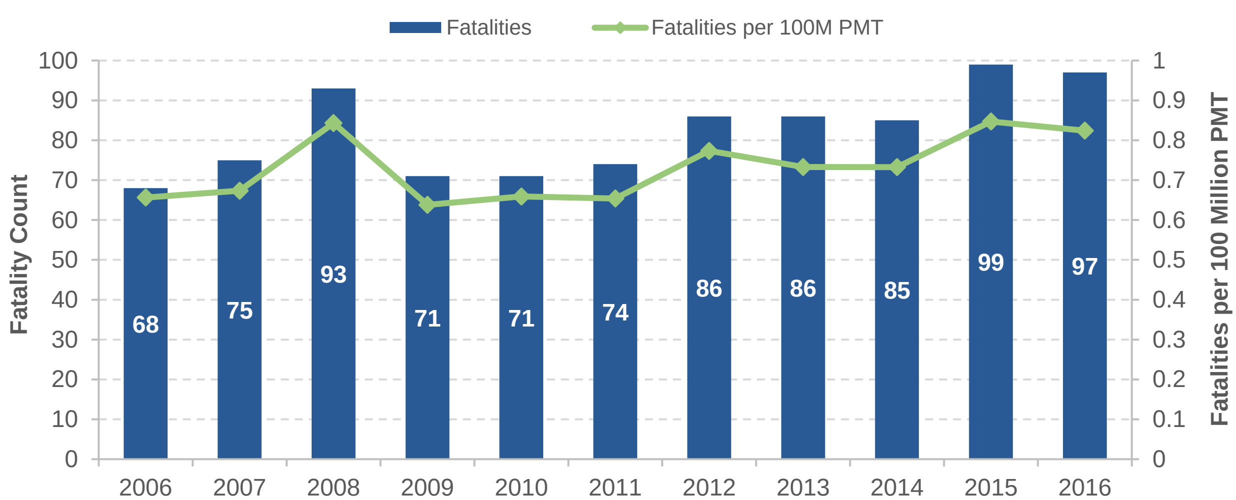
Analysis Parameter	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Incidents Per 100 Million PMT											
Fixed-Route Bus	69.62	66.86	54.15	58.28	55.28	46.26	45.20	47.63	49.07	55.68	55.12
Heavy Rail	42.86	43.49	53.34	53.16	54.62	49.39	48.58	49.87	41.17	41.43	41.27
Light Rail	60.67	61.29	48.58	45.76	40.09	39.68	36.94	40.67	41.40	48.59	47.90
Demand Response	375.15	404.13	204.28	194.77	165.23	151.82	142.48	153.98	165.33	174.43	192.39
Injuries Per 100 Million PMT											
Fixed-Route Bus	62.64	68.89	66.89	72.27	71.96	62.87	62.65	65.30	66.94	73.30	71.65
Heavy Rail	42.86	43.49	53.34	53.16	54.62	49.39	48.58	49.87	41.17	41.43	41.27
Light Rail	60.67	61.29	48.58	45.76	40.09	39.68	36.94	40.67	41.40	48.59	47.90
Demand Response	375.15	404.13	204.28	194.77	165.23	151.82	142.48	153.98	165.33	174.43	192.39

Source: National Transit Database.

Commuter Rail Fatalities, Incidents, and Injuries, Excluding Suicides

The RAIRS database records fatalities that occurred because of a commuter rail collision, derailment, or fire. The database also includes a category called "not otherwise classified," which includes fatalities that occurred because of a slip, trip, or fall (suicides not included). *Exhibit 5-19* shows the number of fatalities, and the fatality rate, for commuter rail. Following a significant decrease in 2009, both measures have shown a general upward trend since 2010. For commuter rail, the total number of fatalities in 2016 was 97, with a fatality rate of 0.82—significantly higher than the national aggregate rate of 0.58.

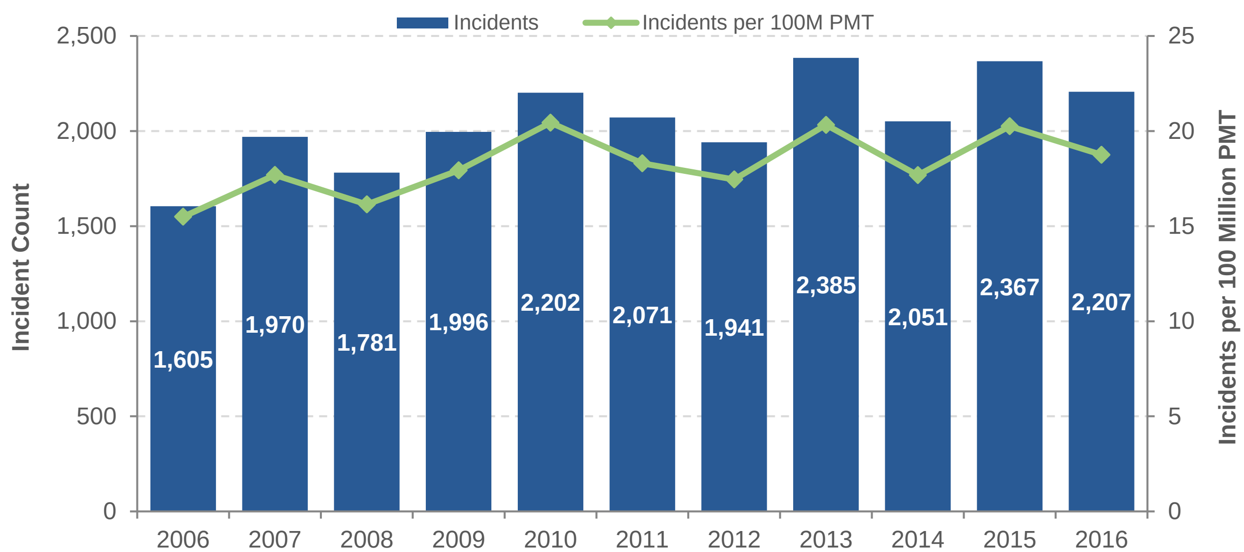
Exhibit 5-19 ■ Commuter Rail Fatalities, 2006–2016



Source: Federal Railroad Administration Rail Accident/Incident Reporting System.

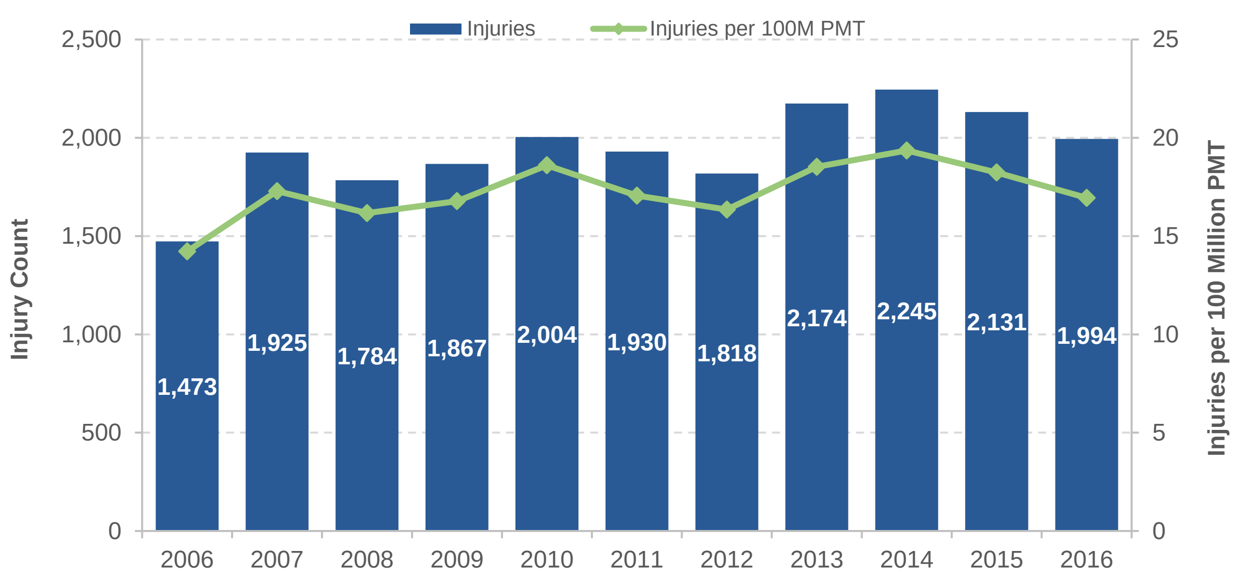
Exhibits 5-20 and *5-21* show the number of commuter rail incidents and the number of injuries per 100 million PMT, respectively. Although commuter rail has a very low number of incidents per PMT, commuter rail incidents are far more likely to result in fatalities than incidents occurring on any other mode. One contributing factor could be that the average speed of commuter rail vehicles is considerably higher than the average speeds of other modes (except vanpools). The number of both incidents and injuries declined from 2007 to 2008, steadily increased through 2010, then declined again between 2011 and 2012 before increasing through 2013. Incidents increased through 2015 and decreased in 2016, whereas injuries decreased through 2016. The average rates of increase for commuter rail fatalities, incidents, and injuries from 2006 to 2016 are 3.6 percent, 3.1 percent, and 3.2 percent, respectively.

Exhibit 5-20 ■ Commuter Rail Incidents, 2006–2016



Source: Federal Railroad Administration Rail Accident/Incident Reporting System.

Exhibit 5-21 ■ Commuter Rail Injuries, 2006–2016



Source: Federal Railroad Administration Rail Accident/Incident Reporting System.