THE

SAFE SYSTEM

APPROACH

INTEGRATING THE

Safe System Approach

WITH THE

Highway Safety Improvement Program

AN INFORMATIONAL REPORT

U.S.Department of Transportation
Federal Highway Administration

Safe Roads for a Safer Future
Investment in roadway safety saves lives

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16. Abstract

The purpose of this report is to explore the relationship between the Safe System approach and the HSIP. This report focuses on the two major components of the HSIP: the States' Strategic Highway Safety Plan (SHSP) and the program of highway safety improvement projects (or States' HSIP), as well as foundational elements of the HSIP that influence both program areas. The report first defines the principles and core elements of the Safe System approach. The report then examines foundational elements of the HSIP, State SHSP, and State HSIP as compared to the Safe System principles and presents areas of alignment, as well as opportunities and noteworthy practices. The report concludes with a discussion of next steps for Federal and State safety stakeholders to advance implementation of the Safe System approach through these existing safety programs. The primary target audience for this report is Federal and State safety stakeholders involved in the State SHSP and HSIP. The report may also benefit other safety stakeholders that have a vested interest in these existing safety programs or administer similar efforts at the regional or local level (e.g., State safety program, local road safety plans).

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Introduction

Traffic safety is a public health crisis affecting all road users, and it demands a concerted response. Each year, more than a million lives are lost globally from traffic crashes.[1] Road traffic crashes are the eighth leading cause of death globally.[2] In 2018, an average of more than 100 people lost their lives on roads in the United States (U.S.) every day.[3] For the past 3 years, fatalities on U.S. roads are the highest they have been in 10 years.[4] Even more troubling, the number of pedestrians struck and killed by a motor vehicle has increased by more than 50 percent in the past decade.[5] Although pedestrian fatalities in 2017 slightly decreased,[6] 2018 (the last year on record at time of publication) was the deadliest, since 1990, for people killed by motor vehicles while walking.[7] This is unacceptable.

Crashes can irreversibly change the course of human lives, touching victims, their families and loved ones, and society as a whole. But we do not have to simply accept death or serious injury as a consequence of using our roadway system. Through collective action from all roadway system stakeholders—from system managers and vehicle manufacturers to law enforcement and everyday users—we can move to a Safe System approach that helps to anticipate human mistakes and keeps impact energy on the human body at tolerable levels, with the goal of eliminating fatalities and serious injuries for all road users.

Implementing the Safe System approach requires evaluating the current state of practice, evolving the approach for consistency, and institutionalizing the paradigm shift.

Imagine a future in the United States where no one dies in a traffic-related crash. Thinking about safety requires a paradigm shift in how we perceive the problem. Rather than accepting fatalities and serious injuries as a price for mobility, the philosophy of the Safe System approach is grounded in an ethical imperative that no one should be killed or injured when using the roadway system.

The Safe System approach is a worldwide movement that has been in place across the globe for more than 30 years. The Federal Highway Administration's (FHWA) top priority is safety. FHWA fully supports the vision of zero deaths and serious injuries on the Nation's roadway system and recognizes that a Safe System is how we get there.

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[1] World Resources Institute (WRI), Sustainable and Safe: A Vision and Guidance for Zero Road Deaths (2018), https://www.wri.org/publication/sustainable-and-safe-vision-and-guidance-zero-road-deaths.
[2] World Health Organization (WHO), "The top 10 causes of death" (May 2018), https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death.
[3] National Highway Traffic Safety Administration (NHTSA), Fatality Analysis Reporting System (FARS) database, https://www-fars.nhtsa.dot.gov/Main/index.aspx.
[4] NHTSA, FARS database, https://www-fars.nhtsa.dot.gov/Main/index.aspx.
[5] NHTSA, FARS database, https://www-fars.nhtsa.dot.gov/Main/index.aspx.
[6] NHTSA, FARS database, https://www-fars.nhtsa.dot.gov/Main/index.aspx.
[7] NHTSA, FARS database, https://www-fars.nhtsa.dot.gov/Main/index.aspx.

Implementing the Safe System approach requires evaluating the current state of practice, evolving the approach for consistency, and institutionalizing the paradigm shift. The Highway Safety Improvement Program (HSIP), which sets the funding and policy tone for national safety implementation efforts, is a key place to start.

The Safe System Approach

A Safe System approach acknowledges that the human body is vulnerable, in terms of the amount of kinetic energy transfer a body can withstand. This vulnerability is taken into account when designing and operating a transportation network to minimize serious consequences of crashes. According to the World Health Organization, the goal of a Safe System is to ensure that if crashes do occur, they "do not result in serious human injury."[8] As shown in figure 1, a Safe System approach addresses the five elements of a safe transportation system—safe road users, safe vehicles, safe speeds, safe roads, and post-crash care—in an integrated manner, through a wide range of interventions.

Figure 1. Illustration. The Safe System approach. (Source: FHWA)

The Safe System approach to road safety started internationally as part of the Vision Zero proclamation that, from an ethical standpoint, no one should be killed or seriously injured on the road system.[9,10] It is founded on the principle that people make mistakes, and that the road system should be adapted to

[8] WHO, *Decade of Action for Road Safety 2011–2020* (2011), 9, https://www.who.int/roadsafety/decade_of_action/plan/plan_en.pdf.
[9] R. Johansson, "Vision Zero - Implementing a Policy for Traffic Safety," *Safety Science* 47 (2009): 826–831.
[10] C. Tingvall and N. Haworth, "An Ethical Approach to Safety and Mobility" (paper presented at the *6th ITE International Conference Road Safety and Traffic Enforcement,* September 6–7, 1999, Melbourne, Australia).

anticipate and accommodate human mistakes and physiological and psychological limits.[11] Countries that have adopted the Safe System approach have had significant success reducing highway fatalities, with reductions in fatalities between 50 and 70 percent.[12]

In the United States, nearly 50 cities have adopted a Vision Zero policy.[13] They are supported by the Toward Zero Deaths (TZD) national strategy on highway safety to advocate for eliminating serious injuries and deaths on our Nation's roadways, conceptualized by participants in an FHWA workshop in 2009.[14] While TZD focuses on the importance of creating a culture of safety, and Vision Zero focuses on eliminating deaths and serious injuries, few local or national plans had explicitly stated the importance of a Safe System approach in achieving these goals. However, in 2018, the RAND® Corporation and the National Safety Council released *The Road to Zero*, a strategy document that has been held up by road safety experts as a national model since its publication.[15] *The Road to Zero* is built on a foundation of the Safe System approach, calling for the United States to "prioritize safety by adopting a Safe System approach and creating a positive safety culture."[16]

The Institute of Transportation Engineers (ITE) and the Road to Zero Coalition's *Safe Systems Framework*[17] articulate that to anticipate human mistakes, a Safe System seeks to:

- Separate users in a physical space (e.g., sidewalks, dedicated bicycle facilities)
- Separate users in time (e.g., pedestrian scramble, dedicated turn phases)
- Alert users to potential hazards
- Accommodate human injury tolerance through interventions that reduce speed or impact force

Creating a Safe System means shifting a major share of the responsibility from road users to those who design the road transport system. "Individual road users have the responsibility to abide by laws and regulations"[18] and do so by exhibiting due care and proper behavior on the transportation system. While road users are responsible for their own behavior, that behavior should not result in a fatality or serious injury in a culture of shared responsibility among road users and those who design, operate, and maintain

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[11] M.-Å. Belin, P. Tillgren, and E. Vedung, "Vision Zero - A Road Safety Policy Innovation," *International Journal of Injury Control and Safety Promotion* 19 (2012): 171–179.

[12] WRI, *Sustainable and Safe: A Vision and Guidance for Zero Road Deaths*, https://www.wri.org/publication/sustainable-and-safe-vision-and-guidance-zero-road-deaths.

[13] Vision Zero Network, Vision Zero Communities Map, retrieved from https://visionzeronetwork.org/resources/vision-zero-cities/.

[14] Toward Zero Deaths, retrieved from https://www.towardzerodeaths.org/.

[15] National Safety Council (NSC) and the RAND® Corporation, *The Road to Zero: A Vision for Achieving Zero Roadway Deaths by 2050* (2018), https://www.nsc.org/Portals/0/Documents/DistractedDrivingDocuments/Driver-Tech/Road%20to%20Zero/The-Report.pdf?ver=2018-04-17-111652-263.

[16] NSC and the RAND® Corporation, *The Road to Zero* (2018), paragraph 3, https://www.nsc.org/Portals/0/Documents/DistractedDrivingDocuments/Driver-Tech/Road%20to%20Zero/The-Report.pdf?ver=2018-04-17-111652-263.

[17] Institute of Transportation Engineers (ITE), *Safe Systems Framework* (November 2019), https://www.ite.org/pub/?id=C8B1C6F9-DCB5-C4F3-4332-4BBE1F58BA0D.

[18] WHO, *Decade of Action for Road Safety 2011–2020* (2011), 9, https://www.who.int/roadsafety/decade_of_action/plan/plan_en.pdf.

the transportation network, which includes road designers and managers; the automotive industry; police; elected officials; and government bodies.[19]

Purpose, Target Audience, and Structure of Report

The first step in initiating a paradigm shift to a Safe System is through education of Federal, State and local transportation safety leaders. As part of that education, we also need to understand how to advance Safe System implementation efforts through our existing programs and projects.

The purpose of this report is to explore the relationship between the Safe System approach and the HSIP. This report focuses on the two major components of the HSIP: the States' Strategic Highway Safety Plan (SHSP) and the program of highway safety improvement projects (or States' HSIP), as well as foundational elements of the HSIP that influence both program areas.

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[19] WHO, *Decade of Action for Road Safety 2011–2020* (2011), https://www.who.int/roadsafety/decade_of_action/plan/plan_en.pdf.

Safe System Principles and Core Elements

The Core Principles of a Safe System

The fundamental objective of the Safe System approach aims to eliminate fatalities and serious injuries for all road users by accommodating human mistakes and keeping impacts on the human body at tolerable levels. What distinguishes the Safe System approach from the traditional safety approach is that no death or level of injury is acceptable in a transportation network. The core principles of a Safe System are shown in figure 2.

Figure 2. Illustration. The Safe System core principles. (Source: FHWA)

Death/Serious Injury Is Unacceptable

While no crashes are desirable, the Safe System approach prioritizes crashes that result in death and serious injury. The Safe System approach is grounded in the imperative that no one should be killed or injured when using the road system, and decisions for designing and operating the system should prioritize safety.

Humans Make Mistakes

A Safe System assumes that road users are alert and compliant, but will inevitably make mistakes that can lead to crashes. The transportation system can be designed and operated to accommodate human mistakes and injury tolerances and avoid death and serious injuries. An example of designing a roadway to accommodate human mistakes is adding a median barrier to prevent errant drivers from entering oncoming traffic.

Humans Are Vulnerable

The human body has limits for tolerating crash forces before death and serious injury occur; therefore, it is important to design and operate a transportation system that is human-centric and accommodates human vulnerabilities. This concept is illustrated in figure 3.

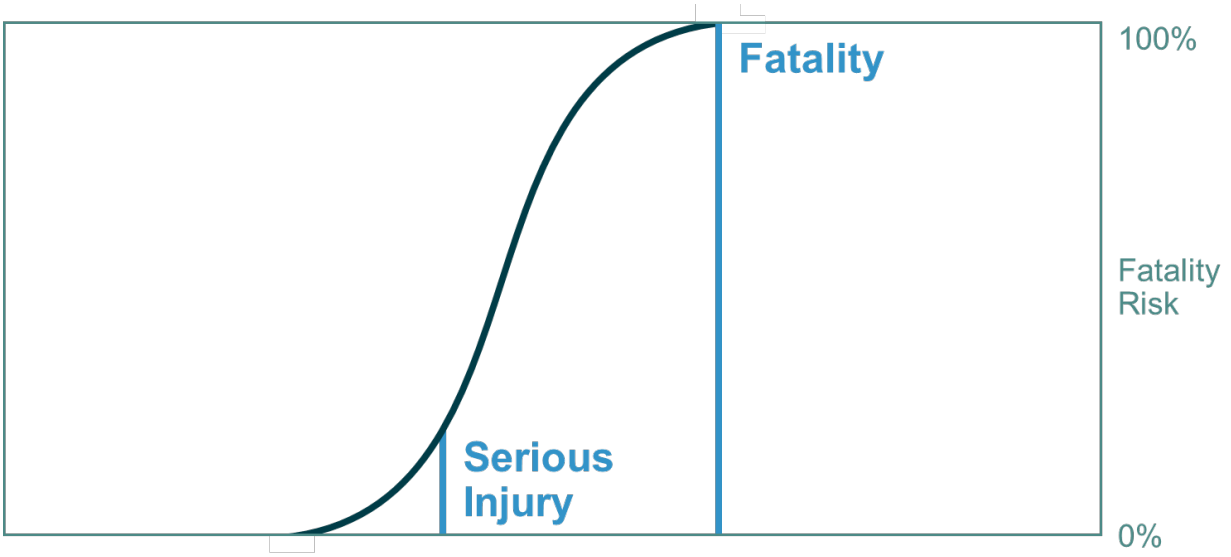

Figure 3. Graph. Relationship between kinetic energy and crash severity. (Source: FHWA)

As figure 3 shows, the human body has limited tolerance for crash impacts before death or serious injury occur. Managing kinetic energy transfer within survivable limits is important for understanding how to design and operate the road system consistent with the Safe System philosophy. The Safe System approach focuses not just on managing speed but managing the transfer of kinetic energy.

Responsibility Is Shared

In a Safe System, all stakeholders work together in a manner that recognizes we are responsible for doing our part, so that crashes do not lead to fatalities or serious injuries. Stakeholders include, but are not limited to, road users, system managers (includes planners, designers, builders, operators, maintainers), law enforcement, emergency responders, and vehicle manufacturers. For example, system designers propose facilities with proven safety countermeasures such as roundabouts or median barriers, system maintainers keep roadway systems in a state of good repair, vehicle manufacturers apply the latest safety features in vehicles, law enforcement equitably enforce traffic safety laws, and users of all travel modes safely move through the roadway system.

Safety Is Proactive

Roadway system managers should use proactive tools to identify and mitigate latent risks in the roadway system, rather than waiting for crashes to occur and reacting afterwards. This process, known as the systemic approach to safety, uses crash history, roadway design characteristics, and other data to identify patterns in geometric design that lead to certain crash types. System designers then identify appropriate countermeasures to mitigate the crash types. These countermeasures are systemically applied at all locations meeting the particular geometric design, irrespective of crash history. Rather than managing risk at certain locations, a systemic approach takes a broader view and evaluates risk across an entire roadway system. A system-based approach acknowledges that crashes alone are not always sufficient to determine what countermeasures to implement. In particular, on low-volume local and rural roadways where crash densities are lower, and in many urban areas where there are conflicts between vulnerable road users (pedestrians, bicyclists, and motorcyclists) and vehicles.

Redundancy Is Crucial

Reducing crash potential requires all parts of the system to be strengthened so that if one part fails, other parts still protect roadway users. An example of redundancy is rumble strips, which protect people when their own ability to be safe road users is compromised by distraction or drowsiness. Redundancy is critical across all five elements of a Safe System, outlined in the next section.

The Five Elements of a Safe System

As defined by FHWA and in alignment with international non-governmental organizations, figure 4 illustrates the five elements of a Safe System.

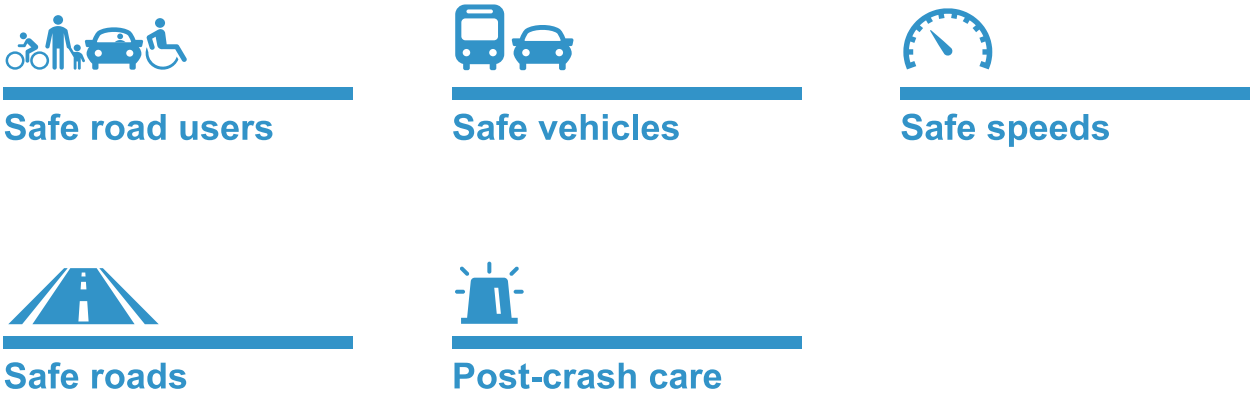

Figure 4. Illustration. The five elements of a Safe System. (Source: FHWA)

These five elements apply to all roads, including freeways, local roads, and rural roads. None of the elements are sufficient on their own, and they should not be addressed in silos. When they are all taken into consideration and implemented as a whole, in a coordinated approach, the entire transportation network becomes safer.

Safe Road Users

As part of the shared responsibility for safety, road users are expected to comply with rules of the road, including paying attention, adapting to changing conditions, not driving under the influence, and driving without distraction. Roadway design, education, enforcement, and vehicle feedback components (e.g., speedometer, automated driving systems) are all important in enabling and encouraging road users to behave safely.

Safe Vehicles

Safe vehicles include active safety measures, which help prevent crashes from occurring (e.g., autonomous emergency braking), and passive safety measures, which protect occupants when a crash occurs (e.g., seatbelts and airbags). Yet, while vehicles have become safer for occupants, pedestrian deaths have increased in the United States.[20] Safe vehicles should also account for the safety of other road users through elements such as vehicle size, design, and materials. Although safety is often touted as the primary benefit of an automated or autonomous vehicle fleet, a safer system is not inherent to smart infrastructure and technological innovation. Elements such as bicyclist and pedestrian detection on connected vehicles (CV) and autonomous vehicles (AV) will be necessary so that vehicles are safe for all road users in the future.

Safe Speeds

According to the Organisation for Economic Co-operation and Development (OECD), "Speed is at the heart of a forgiving road transport system. It transcends all aspects of safety: without speed there can be no movement, but with speed comes kinetic energy, and with kinetic energy and human mistakes come crashes, injuries, and even deaths."[21] In 2017, the National Transportation Safety Board (NTSB) released *Reducing Speeding-Related Crashes Involving Passenger Vehicles*,[22] a report that stated, "Substantial reductions in highway crashes cannot be achieved without a renewed emphasis on the impact of speeding."[23]

Maintaining safe speeds can help avoid crashes, as well as mitigate injury severity by reducing the speed at which impacts occur. Speed-limit-setting methodologies that provide alternatives to the traditional 85th percentile approach, such as USLIMITS2,[24] can help determine appropriate speeds based on roadway context and modal priority, rather than the historic behavior of road users. Roadway design focused on

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[20] Governors Highway Safety Association, *Pedestrian Traffic Fatalities by State: 2018 Preliminary Data* (2019), https://www.ghsa.org/sites/default/files/2019-02/FINAL_Pedestrians19.pdf.

[21] International Transport Forum (ITF), *Zero Road Deaths and Serious Injuries: Leading a Paradigm Shift to a Safe System* (2016), 107, http://www.towardszerofoundation.org/wp-content/uploads/2016/10/Zero_road_deaths-SafeSystems.pdf.

[22] National Transportation Safety Board (NTSB), *Reducing Speed-Related Crashes Involving Passenger Vehicles* (July 2017), https://www.ntsb.gov/safety/safety-studies/Documents/SS1701.pdf.

[23] NTSB, "Study Identifies Opportunities to Reduce Speeding-Related Deaths and Serious Injuries" (July 2017), paragraph 5, https://www.ntsb.gov/news/press-releases/Pages/pr20170714.aspx.

[24] Federal Highway Administration (FHWA), "USLIMITS2," page last modified April 28, 2020, https://safety.fhwa.dot.gov/uslimits/.

speed management, such as target speed-based design, is key to achieve target operating speeds. Many of these design strategies are highlighted in FHWA's *Speed Management: A Manual for Local Rural Road Owners*[25] and *Speed Management Toolkit*.[26] Enforcing existing speed limits, including automated enforcement, and educating road users also play a role in contributing to driver compliance with speed limits. Speed harmonization strategies can also be used to achieve safe speeds in congested areas.

Safe Roads

In a Safe System, driver behavior is taken into consideration as a part of engineering design. Design features and safety countermeasures—many of which are the primary focus of the HSIP—can contribute to safe roads by separating users in space and time. This separation can also be designed temporally, as with traffic signals, to mitigate conflicts between road users and reduce the risk of a crash. Safe roads also include clear zones where objects are relocated away from the road, or roadside appurtenances designed to mitigate severity when roadway departures do occur. In an urban setting, vertical and horizontal separation can create additional space between heavier and faster vehicles and slower and smaller road users who are walking or cycling. Roundabouts, when designed well, are a countermeasure that can significantly reduce speed at intersections. Design designations, such as functional class and modal priority, can also support safe roads. Understanding functional class and modal priority can help to pinpoint the set of safety countermeasures that may be most effective on a given type of facility.

Post-Crash Care

In a Safe System, post-crash care incorporates elements related to emergency services and medical care, crash reporting and investigation, traffic incident management, and the justice system. Health outcomes for victims injured in serious crashes can be heavily dependent on the ability of emergency services to quickly respond to the scene of a crash, administer on-site care, transport victims to the hospital, and provide care at the hospital and after discharge (if necessary). The post-crash response in a Safe System extends beyond emergency services. Quick-response and detailed investigation by police and road managers/operators can help ensure crash factors are documented and reported correctly, the justice system can take appropriate action, and the risk of future crashes can be mitigated through an appropriate design and program or policy changes. Crash reporting practices, such as complete data collection and documentation of road user behavior and infrastructure, and sharing data across agencies or organizations (e.g., among police departments, transportation officials, and hospitals) can help lead to a greater understanding of the holistic safety landscape, and thus lead to improved investments in safety.

Design designations, such as functional class and modal priority, can support safe roads.

[25] FHWA, *Speed Management: A Manual for Local Rural Road Owners*, FHWA-SA-12-027 (November 2012), https://safety.fhwa.dot.gov/local_rural/training/fhwasa010413spmgmt/.

[26] FHWA, *Speed Management Toolkit*, FHWA-SA-15-017, https://safety.fhwa.dot.gov/speedmgt/ref_mats/docs/speedmanagementtoolkit_final.pdf.

Summary

This chapter summarized the Safe System approach, and the six core principles and five elements that are foundational for a Safe System and shown in figure 5.

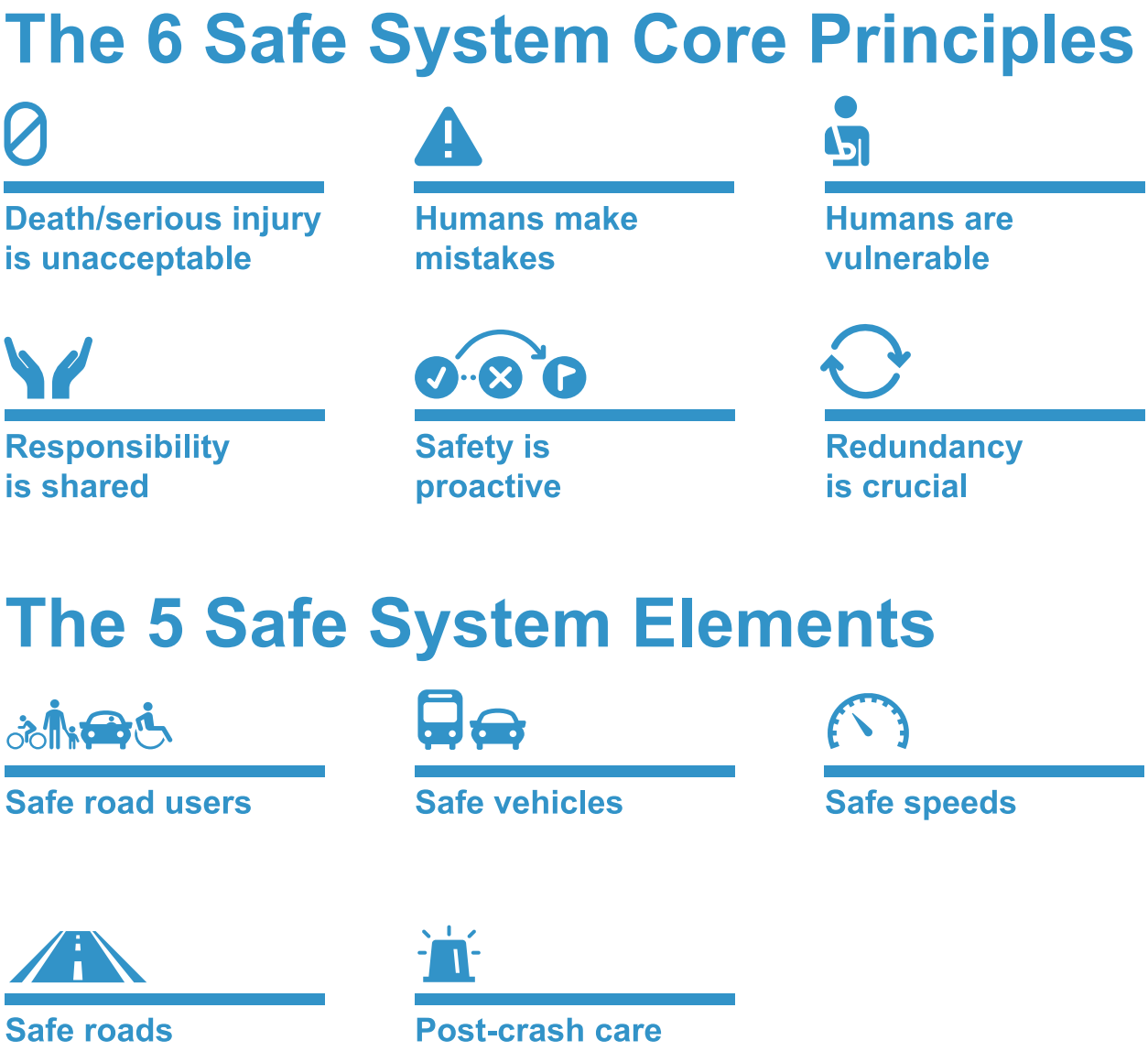

Figure 5. Illustration. Summary of Safe System core principles and elements. (Source: FHWA)

The following chapters present the foundational elements of the HSIP, and major program features of the States' SHSP and the States' HSIP, and describe how each step is aligned with Safe System principles, as well as opportunities and noteworthy practices to better integrate the Safe System approach in these existing safety programs.

Integrating Safe System within HSIP

Overview

The HSIP is a core Federal-aid highway program with the purpose to significantly reduce fatalities and serious injuries on all public roads through the implementation of highway safety improvement projects. The HSIP is a federally funded, State-administered program established under 23 U.S.C. 148. The HSIP requirements are further clarified and defined by FHWA in 23 CFR Part 924. Each State develops and administers a program to best meet its safety needs. The HSIP requires a data-driven, strategic, and performance-based approach to improving highway safety on all public roads.

The Moving Ahead for Progress in the 21st Century (MAP–21) Act introduced a performance-based framework for the Federal-aid highway program and established national safety goals and safety performance measures for the purposes of carrying out the HSIP (MAP–21 §1203; 23 U.S.C. 150). The FHWA further defined and clarified the safety performance management requirements in 23 CFR Part 490. Effective April 14, 2016, FHWA required States to set annual safety performance targets for the number of fatalities, number of serious injuries, rate of fatalities, rate of serious injuries, and number of non-motorized fatalities plus serious injuries.[27] The safety performance targets are interim performance levels that contribute toward the progress of the long-term goal of zero fatalities adopted by many States. According to the International Transport Forum, "Setting targets for the total number of fatalities and serious injuries has shown to be an important driver for initiating and realizing effective national road strategies."[28]

> "Setting targets for the total number of fatalities and serious injuries has shown to be an important driver for initiating and realizing effective national road strategies."
>
> - International Transport Forum

The program's purpose and safety performance management requirements are foundational elements that influence both the State SHSP and HSIP. The following section describes how these foundational elements of the HSIP align with and support implementation of the Safe System approach. Subsequent chapters provide specific opportunities and noteworthy practices to further align these foundational elements within the State SHSP and HSIP. Figure 6 illustrates the relationship between the HSIP, State HSIP, and State SHSP.

[27] FHWA, "State Safety Performance Targets," page last modified July 8, 2020, https://safety.fhwa.dot.gov/hsip/spm/state_safety_targets/.

[28] ITF, *Zero Road Deaths and Serious Injuries* (2016), 67, http://www.towardszerofoundation.org/wp-content/uploads/2016/10/Zero_road_deaths-SafeSystems.pdf.

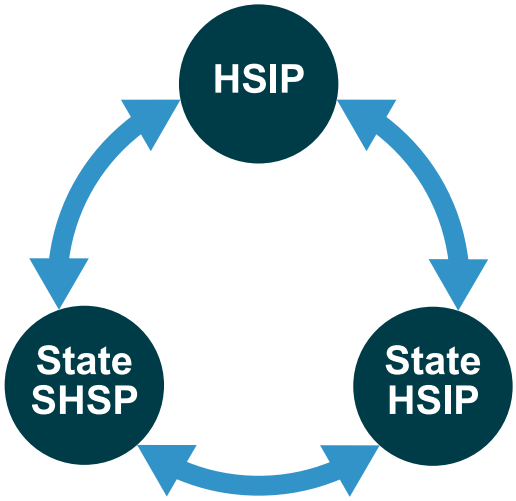

Figure 6. Illustration. Relationship between HSIP, State HSIP, and State SHSP. (Source: FHWA)

Alignment of Safe System Principles with HSIP Foundational Elements

The foundational elements of the current HSIP have some alignment with the Safe System principles. This alignment is illustrated and further described in table 1.

Table 1. Safe System alignment with HSIP foundational elements.

Purpose The purpose of the HSIP is "to achieve a significant reduction in traffic fatalities and serious injuries on all public roads, including non-State-owned public roads and roads on tribal lands. The HSIP requires a data-driven, strategic approach to improving highway safety on all public roads that focuses on performance."[29]		
Safe System Principle	**Alignment**	**Discussion**
Death/Serious Injury Is Unacceptable	◑	The HSIP is focused on reducing fatalities and serious injuries; however, it could be further strengthened to focus on eliminating death and serious injury.
Humans Make Mistakes	○	The purpose of the HSIP program does not acknowledge human mistakes.
Humans Are Vulnerable	◑	The purpose of the HSIP acknowledges human vulnerability by focusing on fatalities and serious injuries, but it does not explicitly state this Safe System principle.

[29] FHWA, "Highway Safety Improvement Program," page last modified February 8, 2017, https://www.fhwa.dot.gov/fastact/factsheets/hsipfs.cfm.

Safe System Principle	Alignment	Discussion
Responsibility Is Shared	◑	The HSIP's program structure acknowledges that responsibility for roadway safety is shared between Federal, State and local partners, across disciplines (education, enforcement, engineering, EMS), and that collaboration is key. It does not, however, explicitly state that everyone has a responsibility for roadway safety consistent with the Safe System approach.
Safety Is Proactive	●	The existence of the HSIP demonstrates proactivity for improving roadway safety.
Redundancy Is Crucial	○	Redundancy is not explicitly stated in the purpose of HSIP; however, as noted above, it does acknowledge that safety is a shared responsibility and that it takes collaboration across disciplines to save lives.

Safety Performance Management Requirements

The HSIP process is built on a foundation of setting and working toward achieving safety performance targets. States are required to set annual safety performance targets through HSIP (23 CFR Part 490), including number and rate of fatalities and serious injuries, and number of non-motorized fatalities and serious injuries.

Safe System Principle	Alignment	Discussion
Death/Serious Injury Is Unacceptable	●	Since 2018, States have annually set safety performance targets, and in each following year, FHWA assesses States' progress in meeting those targets. The safety performance targets align with the SHSP long-term goals and multiyear objectives. In addition, the projects, strategies, and activities funded through the States' HSIP helps them make progress in achieving their safety performance targets.
Humans Make Mistakes	○	Safety performance targets do not explicitly address human mistakes.
Humans Are Vulnerable	◑	Safety performance targets are set around death and serious injury, which implicitly recognizes that humans are vulnerable. However, safety performance targets do not explicitly state this Safe System principle.
Responsibility Is Shared	◑	State departments of transportation (DOTs) are accountable to FHWA, and State Highway Safety Offices are accountable to the National Highway Traffic Safety Administration (NHTSA) for progress toward meeting their safety performance targets. However, not all parties who should be involved in making roadways safer are acknowledged through safety performance management requirements.
Safety Is Proactive	◑	By setting safety performance targets, States are taking the first step in being proactive and accountable for roadway safety issues.
Redundancy Is Crucial	○	Redundancy is not explicitly stated in safety performance targets.

● Full Alignment ◑ Partial Alignment ○ Minimal Alignment/Not Applicable

The foundational elements of the HSIP primarily support the Safe System principles that *Death and Serious Injury Is Unacceptable* and *Safety Is Proactive*. The purpose of the HSIP is focused on reducing fatalities and serious injuries and the safety performance management requirements holds States accountable for meeting their fatality and serious injury-based safety performance targets. The fact that the United States has a dedicated Federal safety program shows our commitment to proactively addressing safety and is a key component of a Safe System approach. While the principles that *Humans Make Mistakes* and *Redundancy Is Crucial* are minimally aligned with the HSIP foundational elements, these principles are addressed by other State SHSP and HSIP program features.

Summary

This chapter outlined if the HSIP foundational elements are minimally, partially, or fully aligned with the core principles of a Safe System, and discussed how the existing alignments support implementation of a Safe System approach. Subsequent chapters provide specific opportunities and noteworthy practices to further align these foundational elements within the State SHSP and HSIP. The following chapter explores opportunities and noteworthy practices for aligning SHSPs with the Safe System approach.

Integrating Safe System with Strategic Highway Safety Plans

Overview

As part of the HSIP, States are required to develop SHSPs to provide a "comprehensive framework for reducing highway fatalities and serious injuries on all public roads."[30] States must update their SHSPs no later than 5 years from the date of the previously approved version (23 CFR 924.9(a)(3)(i)). The SHSPs help guide investment decisions made in the HSIP process toward projects that focus on mitigating the highest priority safety issues in each State.

According to 23 CFR 924.9, each SHSP must include: 1) safety data collection and analysis, 2) selection of emphasis areas that identify key safety opportunities to reduce crash potential that had emerged from the analysis, 3) development of measurable objectives in mitigating fatalities and serious injuries within the emphasis areas, and 4) identification of strategies across the 4 E's (i.e., engineering, education, enforcement, and emergency response) to address these objectives. Certain States have begun to use the SHSP as an opportunity to set an intention, policy, and funding framework following the Safe System approach.

The SHSP is a key opportunity to further develop and communicate the Safe System approach. The following sections demonstrate how the Safe System principles align with the major components of the SHSP process, as well as opportunities and noteworthy practices to further advance implementation of Safe System through State SHSPs.

[30] FHWA, "Strategic Highway Safety Plan (SHSP)," page last modified June 16, 2017, https://safety.fhwa.dot.gov/shsp/.

Alignment of Safe System Principles with Major SHSP Features

As shown in table 2, the components of SHSPs most aligned with Safe System principles are the use of effective strategies and countermeasures and the multidisciplinary approach that addresses the 4 E's. This alignment is further described in the following section.

Table 2. Safe System alignment with SHSP major program features.

Ensure Adequate Leadership, Collaboration, and Communication Implementation of the plan is in coordination with other statewide safety partners and programs and involves a broad range of agencies. According to the International Transport Forum, leadership is a key element of a successful paradigm shift to a Safe System.[31] The recently published Core Elements for Vision Zero Communities, from the Institute of Transportation Engineers (ITE) and the Vision Zero Network, focuses four of its 10 elements on the importance of leadership and commitment.[32]		
Safe System Principle	**Alignment**	**Rationale**
Death/Serious Injury Is Unacceptable	○	The principle that death and serious injury is unacceptable is not present in this program feature.
Humans Make Mistakes	○	This key program feature does not acknowledge that humans make mistakes.
Humans Are Vulnerable	○	The principle that humans are vulnerable is not present in this program feature.
Responsibility Is Shared	●	SHSP leadership engages a cross-disciplinary leadership group in collaboration around roadway safety is an important foundation in recognizing the importance of shared responsibility.
Safety Is Proactive	○	A proactive approach is not present in this program feature.
Redundancy Is Crucial	◑	Engaging a cross-disciplinary leadership group on the topic of roadway safety can help start conversations about the importance of redundancy in the roadway system, but the concept of redundancy is not inherent in this program feature.

● Full Alignment ◑ Partial Alignment ○ Minimal Alignment/Not Applicable

[31] ITF, *Zero Road Deaths and Serious Injuries* (2016), 67, http://www.towardszerofoundation.org/wp-content/uploads/2016/10/Zero_road_deaths-SafeSystems.pdf.

[32] Vision Zero Network and Institute of Transportation Engineers, *Core Elements for Vision Zero Communities,* retrieved from https://visionzeronetwork.org/wp-content/uploads/2018/11/VZN_CoreElements_FINAL.pdf.

A Performance-Based Approach

The SHSP process provides an opportunity to establish longer-term goals and objectives that align with annual safety performance targets. This provides consistency and direction across all safety plans and programs.

Safe System Principle	Alignment	Rationale
Death/Serious Injury Is Unacceptable	●	Many State SHSPs list zero deaths or zero deaths plus serious injuries as a goal or include this concept in a policy statement, according to the SHSP database.[33] A performance-based approach focuses not just on commitment, but also on accountability through goal setting and tracking.
Humans Make Mistakes	○	This program feature does not acknowledge that humans make mistakes.
Humans Are Vulnerable	◑	The current performance-based approach is based on a foundation of human vulnerability—death and serious injury—but does not fully incorporate the spirit of this Safe System principle.
Responsibility Is Shared	◑	The performance-based approach can help illuminate shared responsibility between State and local roadway system managers, for example, but it does not account for multidisciplinary shared responsibility among many roadway users.
Safety Is Proactive	◑	Using a performance-based approach is a key first step States can take to be proactive about addressing roadway safety issues.
Redundancy Is Crucial	○	The concept of redundancy is not a part of this program feature.

● Full Alignment ◑ Partial Alignment ○ Minimal Alignment/Not Applicable

[33] FHWA, "Strategic Highway Safety Plan (SHSP) Database Search," https://rspcb.safety.fhwa.dot.gov/shspsearch/statesearch.aspx.

Data-Driven Problem Identification

The SHSPs analyze and make effective use of State, regional, local, or and Tribal safety data. States should use the best available safety data to identify emphasis areas and strategies to inform safety improvement opportunities on all public roads.

Safe System Principle	Alignment	Rationale
Death/Serious Injury Is Unacceptable	●	The goal of data-driven problem identification is to uncover roadway safety issues responsible for death and serious injury.
Humans Make Mistakes	◑	Data-driven problem identification can uncover roadway safety issues related to human mistakes, but it does not emphasize the importance of designing a roadway system that accounts for human mistakes.
Humans Are Vulnerable	◑	In emphasizing fatal and serious injury crashes, human vulnerability is recognized, but this Safe System principle is not a key component of the data-driven approach.
Responsibility Is Shared	◑	Data-driven problem identification can be performed in a collaborative process, but does not necessarily bring all responsible parties into the problem identification process.
Safety Is Proactive	●	The SHSP problem identification has evolved over the years to incorporate both spot and systemic safety analysis. This comprehensive approach should continue to be emphasized and adopted as part of all SHSPs so the strategies that flow from the analysis represent a proactive approach.
Redundancy Is Crucial	○	Redundancy is not a component of data-driven problem identification.

● Full Alignment ◑ Partial Alignment ○ Minimal Alignment/Not Applicable

Use of Effective Strategies and Countermeasures

High priority should be given to strategies that can eliminate roadway fatalities and serious injuries within the SHSP emphasis areas.

Safe System Principle	Alignment	Rationale
Death/Serious Injury Is Unacceptable	◑	Effective strategies and countermeasures should address safety issues that result in death and serious injury. However, research supporting countermeasure use and implementation is often focused on all crashes, not the most severe.
Humans Make Mistakes	◑	Using effective strategies and countermeasures can often address roadway safety issues related to human mistakes, but not all countermeasure implementation builds in the assumption of human error.
Humans Are Vulnerable	◑	Effective strategies and countermeasure help address human vulnerability, but not all countermeasures directly address the impact of speed and kinetic energy transfer on the human body.
Responsibility Is Shared	◑	Effective countermeasures and strategies can be implemented by multidisciplinary partners who are responsible for roadway safety, but it is not guaranteed that all relevant parties will be included in this program feature.
Safety Is Proactive	◑	Implementing effective countermeasures and strategies can be a key step in a proactive approach to addressing roadway safety issues, but countermeasures are often still identified through a reactive crash analysis process.
Redundancy Is Crucial	◑	Although some combinations of countermeasures can introduce redundancy into the roadway system, redundancy is not a major focus of countermeasure identification.

● Full Alignment ◑ Partial Alignment ○ Minimal Alignment/Not Applicable

Multidisciplinary – Address the 4 E's The SHSP addresses a variety of factors, including engineering, education, enforcement, and emergency services (i.e., the 4 E's). This applies to both infrastructure and non-infrastructure emphasis areas.		
Safe System Principle	**Alignment**	**Rationale**
Death/Serious Injury Is Unacceptable	◑	It is implied, but not explicitly stated, that the 4 E's of safety are intended to eliminate death and serious injury.
Humans Make Mistakes	◑	The 4 E's, such as engineering and education, can address roadway safety issues related to human mistakes, but the assumption of human mistakes is not inherent in the 4 E's.
Humans Are Vulnerable	◑	It is implied, but not explicitly stated, that the 4 E's of safety are intended to address human vulnerability related to crashes.
Responsibility Is Shared	●	The existence of the 4 E's demonstrates the importance of shared responsibility in addressing roadway safety issues.
Safety Is Proactive	◑	Addressing all 4 E's can be a key step in a proactive approach to tackling roadway safety issues, but a proactive approach is not inherent to the 4 E's of safety.
Redundancy Is Crucial	●	Redundancy is introduced to the system when engineering, education, enforcement, and emergency services strategies are used together to tackle roadway safety issues.

● Full Alignment ◑ Partial Alignment ○ Minimal Alignment/Not Applicable

The SHSP supports the principle that deaths and serious injuries are unacceptable through the SHSPs performance-based approach and data-driven problem identification. The SHSP emphasizes the importance of shared responsibility by ensuring adequate leadership, collaboration, and communication across stakeholders and identifying multidisciplinary solutions that address the 4 E's. The SHSP data-driven problem identification enables practitioners to proactively address safety, and the multidisciplinary nature of SHSP emphasis areas and strategies promotes system redundancy. It is not reasonable to expect every major SHSP program feature to fully align with each Safe System principle. Collectively, across all major SHSP program features, full alignment exists in at least one major program feature for every Safe System principle except *Humans Make Mistakes* and *Humans Are Vulnerable*. The following section presents opportunities and noteworthy practices to illustrate how Federal, State and local safety stakeholders can enhance SHSP efforts to better align with the Safe System principles.

Opportunities and Noteworthy Practices

The following opportunities and noteworthy practices illustrate key considerations for practitioners to holistically integrate the Safe System approach into the State SHSP.

1. Organize SHSP around Safe System Six Core Principles and Five Elements

The SHSP provides the opportunity to establish leadership reinforcement that death and serious injury are unacceptable within each State. Organizing each State's SHSP around Safe System elements could help to further integrate the approach into application. There are many ways States can integrate Safe System in their SHSP updates. Several options are presented below, and States should consider which approach works best for them.

Align Emphasis Areas: States may choose to fully replace their emphasis areas with the five elements. Each element would incorporate all Safe System principles.

Align Strategies: For instance, if an emphasis area in an existing SHSP is roadway departure, today's SHSP would tie strategies to three of the four Safety E's:[34]

- Engineering – have proper clear zones and shielding, rumble strips, or barriers
- Enforcement – manage speeds through enforcement
- Education – perform outreach on innovations such as high friction surface treatments or the importance of heeding advisory speeds

A Safe System-based SHSP could reimagine that same emphasis area within the framework of the five elements to become the overarching framework of the SHSP emphasis area strategies:

- Safe Road Users – perform outreach through educational programs on how to safely regain the roadway
- Safe Vehicles – implement infrastructure-to-vehicle communication to support lane departure assist
- Safe Speeds – set speed limits based on roadway context and the human body's ability to tolerate crash forces
- Safe Roads – have proper warning treatments and delineation, as well as clear zones and shielding
- Post-Crash Care – provide infrastructure to support emergency services equipment at crash sites for quick response and proper triage (this is especially important in rural communities)

Perform Safe System Assessment: States could retain their emphasis area structures, but perform a Safe System assessment to determine how well an emphasis area aligns with the Safe System elements and principles, and make adjustments as necessary. Each State could perform this assessment as it transitions its SHSP to a Safe System approach. Parties responsible for each emphasis area would identify which Safe

[34] Defined as engineering, education, enforcement, and emergency medical services.

System principle or element is addressed by their action items so they have a balance across the principles and elements as part of a shared responsibility approach.

By reframing the SHSP, States would have a better roadmap for pivoting to the Safe System approach and creating a focus on the six core principles, such as planning for human mistakes and creating redundancy in the roadway system. Stakeholder collaboration would need to be thoughtfully managed to keep engagement high while also shifting to more effective and measurable actions.

Noteworthy Practice: Washington State SHSP Includes "Safe Systems Approach" Chapter
Washington State's 2019 SHSP[35] draws a direct connection between the roadway safety strategy the State is undertaking and Safe System principles. Inclusion of this section goes beyond acknowledging Safe System principles—the State has adopted strategies to implement these principles, including:

- Develop and implement speed management policy, guidelines, and professional training focused on injury minimization
- Complete infrastructure connectivity for pedestrians and bicyclists and make progress toward providing separation where needed based on crash exposure, crash history, and characteristics of the roadway and adjacent land use associated with higher levels of use[36]

States considering adopting this noteworthy practice should consider integrating the Safe System principles and elements throughout their SHSPs.

2. Commit to a "Zero" Goal and Establish Performance Management Strategies

Adopting an SHSP goal of zero deaths and serious injuries encourages States to acknowledge the Safe System principle that "death and serious injury are unacceptable." The zero deaths goal should be present throughout the entire SHSP, and the top priority during implementation. The focus of the SHSP should be on a reduction to zero. For example, "Oregon envisions no deaths or life-changing injuries on Oregon's transportation system by 2035"[37] is a more precise goal than "toward zero deaths." Using plain and direct language to state the "zero" goal helps to align the SHSP with the Safe System principle that death and serious injury are unacceptable.

The SHSP also provides the opportunity to establish leadership reinforcement that death and serious injury are unacceptable within each State. Once precise goals of achieving zero deaths and serious injuries

[35] Washington Traffic Safety Commission, *Washington State Strategic Highway Safety Plan 2019* (2019), http://targetzero.com/wp-content/uploads/2020/03/TargetZero2019_Lo-Res.pdf.
[36] Washington Traffic Safety Commission, *Washington State Strategic Highway Safety Plan 2019* (2019), 203, http://targetzero.com/wp-content/uploads/2020/03/TargetZero2019_Lo-Res.pdf.
[37] FHWA, "Strategic Highway Safety Plan (SHSP) Database Search," https://rspcb.safety.fhwa.dot.gov/shspsearch/statesearch.aspx.

have been set, State safety leaders can show buy-in for these goals through media, public events, and support for related policies and programs.

Noteworthy Practice: Massachusetts Adopts a "Zero" Goal in Alignment with Safe System Principles

As part of its SHSP, each State can adopt a goal of zero deaths and serious injuries, which recognizes the Safe System principle that serious injuries and loss of life are unacceptable. The following statement is from the 2018 Massachusetts SHSP:

> "Every Life Counts: Between 2012 and 2016, 1,820 people lost their lives and 15,662 were seriously injured on Massachusetts roadways. It is imperative that we look at each of these deaths and serious injuries as more than a statistic. We must view the loss of life as unacceptable, and work toward zero deaths and serious injuries on our roadways."[38]

According to the International Transport Forum, "Set targets must be regularly monitored and backed by an agreed and fully funded package of interventions that are selected based on evidence of the results they can be expected to produce."[39] Implementing a more robust performance management approach can help keep States on track in achieving a Safe System. A performance-based approach focuses not just on commitment, but also on accountability through goal setting and tracking. A more robust approach could include the following strategies:

- Backcasting to establish the rate of decrease in fatalities and serious injuries needed to achieve zero by the target year. This approach will allow States to show the level of investments necessary to reach long-term goals. The backcasting can be applied to specific strategies within the SHSP, such as each of the Safe System elements.
- A monitoring process to measure against the backcasting trend and force intervention changes if States are not on track.
- Apply a proactive approach in the SHSP, including the use of systemic profiles, roadway and roadside condition, and modal specific condition assessments (e.g., bicycle network stress or distance between marked crossings).
- Establish key performance indicators (KPIs). According to the European Commission, "KPIs can give a more complete picture of the level of road safety and can detect the emergence of problems at an early stage, before they result in accidents."[40] These key performance indicators could be tied to each of the five Safe System elements or a particular strategy.

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[38] Massachusetts Department of Transportation, *Massachusetts Strategic Highway Safety Plan* (2018), 1, https://www.mass.gov/doc/massachusetts-shsp-2018/download.

[39] ITF, *Zero Road Deaths and Serious Injuries* (2016), 61, http://www.towardszerofoundation.org/wp-content/uploads/2016/10/Zero_road_deaths-SafeSystems.pdf.

[40] European Commission, *Road Safety Strategies and Action Plans in the EU* (January 2018), https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/nl29_en.pdf.

What Is Backcasting and How Does it Apply to a Safe System Approach to Transportation Safety?

Taking from a planning method of system conditions for sustainability developed by Karl-Henrik Robèrt of The Natural Step, backcasting defines a desirable future and then works backward to identify policies and programs that will connect that specified future to the present.[41] Backcasting can be a forecasting approach through SHSPs to achieve a goal of zero fatalities and serious injuries by determining independent variables that might exist to determine what actions need to be taken to get there. Backcasting applies the Safe System principle that transportation safety should be proactive, not reactive, and responsibility is shared. Backcasting in transportation safety has been effective in reducing serious injuries and fatalities in Sweden and the United Kingdom.[42]

How Can KPIs Be Used to Work toward Zero Road Fatalities in a Safe System Approach?

In June 2019, the European Commission published *EU Road Safety Policy Framework 2021-2030 - Next steps towards "Vision Zero"* including key guidance on how to use KPIs as performance measures in achieving Vision Zero using a Safe System approach. This report establishes KPIs through networkwide safety rating required under new European Union rules (first completed assessment expected by the end of 2024). This report highlights that:

> "To measure progress, the most basic – and important – indicators are of course the result indicators on deaths and serious injuries, which will continue to be monitored closely. But as the Safe System approach relies on gaining a much clearer understanding of the different issues that influence overall safety performance, the Commission has elaborated, in close cooperation with Member State experts, a first set of key performance indicators…"

The report provides more detail on the use of KPIs through Safe System approach to achieving Vision Zero, but a key note established is that "a KPI for road infrastructure should show the safety quality of a road network independent of road user behavior or vehicle technology."[43]

3. Refocus Speeding Emphasis Area on Speed Management and Roadway Design

State SHSPs should refocus on speed management and roadway design changes, rather than relying only on education and enforcement strategies to address speeding emphasis areas in the SHSP. This may include more emphasis on designing roads and setting speed limits systemically to achieve a target

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[41] J. Holmberg and K-H Robèrt, "Backcasting from Non-overlapping Sustainability Principles – a Framework for Strategic Planning," *International Journal of Sustainable Development and World Ecology* 7 (2000): 291-308.

[42] John Whitelegg and Gary Haq, *Vision Zero: Adopting a Target of Zero for Road Traffic Fatalities and Serious Injuries* (Stockholm Environment Institute: 2006), https://mediamanager.sei.org/documents/Publications/Future/vision_zero_FinalReportMarch06.pdf.

[43] European Commission, *EU Road Safety Policy Framework* (2019): 5-10. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/1_en_document_travail_service_part1_v2.pdf.

speed. A target speed is "the highest speed at which vehicles should operate on a thoroughfare in a specific context, consistent with the level of multimodal activity generated by adjacent land uses, to provide both mobility for motor vehicles and a safe environment for pedestrians, bicyclists, and public transit users."[44] Using roadway design to reduce speeding related crashes applies the Safe System principles that humans are vulnerable, responsibility is shared, and redundancy is critical. SHSPs should identify approaches to address speed-related serious crashes even when drivers are not exceeding the speed limit. States should understand speed issues through the lens of all five Safe System elements, especially safe speeds. Recognizing and refocusing protection of vulnerable users to serious injury and fatality due to kinetic energy transfer, such as pedestrians and bicyclists, in the SHSPs can help align this emphasis area category with Safe System principles.

When updating State SHSPs, State DOTs can reflect the urgency of recommendations included in the National Transportation Safety Board (NTSB) speed report. As seen in figure 7, even relatively low speeds can result in death or serious injury unless the vehicle and the road environment take account of the physical vulnerability of all road users.

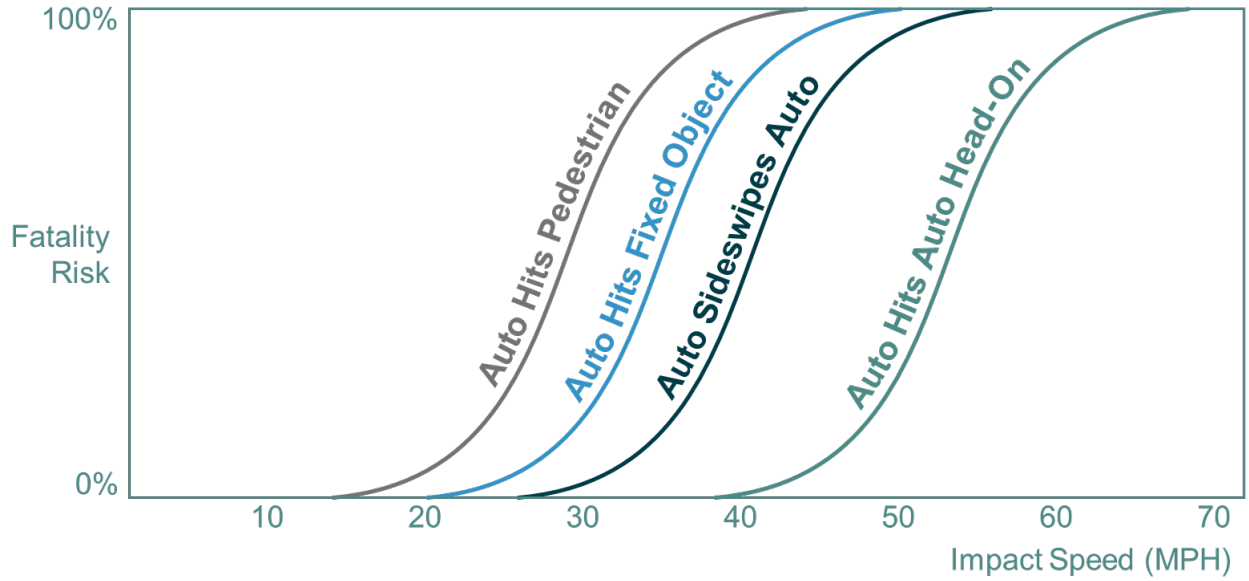

Figure 7. Graph. Relationship between fatality risk and impact speed. (Source: FHWA)

State SHSPs should address designing for safe speeds and speed management to make progress toward zero fatality goals that many States have adopted. States can use Federal resources, such as the NTSB report and FHWA speed management guidance, as the basis for this change. States can include speed management as a primary focus of future SHSPs and consider including speed management principles in all projects. Every SHSP addresses speeding, but HSIP funding is often spent on mitigations for crashes associated with roadway departures, intersection conflicts, and pedestrian facility deficiencies because

[44] Institute of Transportation Engineers, *ITE Recommended Practice on Designing Walkable Urban Thoroughfares: A Context Sensitive Approach* (2010), https://www.ite.org/pub/?id=E1CFF43C-2354-D714-51D9-D82B39D4DBAD.

data analysis based on crash reports points in this direction. However, speed and kinetic energy transfer are typically the key elements of fatalities and serious injuries, even if speeding is not identified as the primary violation. Shifting the focus to the most severe aspect of crashes, and addressing behavior change through infrastructure improvements, helps to align with the shared responsibility Safe System principle.

Although speeding and vulnerable users are common emphasis areas in SHSPs, the current FHWA categorization of emphasis areas may not always allow States to embrace issues related to the kinetic energy transfer at high speeds that support this principle. According to the SHSP database, most States address speed issues from the perspective of speeding and driver behavior, and many States group the speeding emphasis area with the aggressive driving emphasis area.[45] Accordingly, most strategies that address these emphasis areas focus on education and enforcement, rather than how roadway design could help reduce speeding or speeds. Refocusing this emphasis area around speed management and roadway design, and recognizing that speed-related serious crashes happen even when drivers are not exceeding the speed limit, can help States understand speed issues through the lens of all five Safe System elements.

While the focus to address speed in a Safe System points to investment in strategies that redesign the roadway for safer speeds, an opportunity exists to further investigate the role of strategies, such as speed-limit-setting methodologies, beyond the 85th percentile and automated speed enforcement. The FHWA and States can work together to support research that investigates how speed limit setting and automated enforcement strategies can be used as an interim tool to help support a Safe System approach.

[45] WRI, *A Vision and Guidance for Zero Road Deaths* (2018), https://www.wri.org/publication/sustainable-and-safe-vision-and-guidance-zero-road-deaths.

Noteworthy Practice: City of Sacramento, California, Focuses Speed Efforts on Roadway Design

As part of its 2018 Vision Zero Action Plan, Sacramento identified roadway design as the primary tool, in alignment with enforcement efforts, in reducing fatal crashes that occurred at high speeds—regardless of whether the cause of the crash was speeding. The plan also makes clear the connection between crash severity and speed, even in cases where the posted speed limit is deemed to be reasonable (e.g., 30 miles per hour [mph]). States can take a similar approach to the speed emphasis area in their SHSPs and refocus on how roadway design impacts operating speed and ultimately crash severity outcomes. The following is from the Sacramento Vision Zero Action Plan:

> "Speed Kills: A major component of Vision Zero is the recognition that speed kills. Research compiled by the U.S. Department of Transportation National Highway Traffic Safety Administration shows that the likelihood of fatality is 5 percent for a pedestrian struck by a vehicle traveling at 20 miles per hour, but the likelihood increases to 40 percent at 30 miles per hour and to 100 percent at 50 miles per hour.
>
> By just designing our streets differently, we can lower the speeds at which vehicles travel to help reduce the severity of injuries. Street design changes, combined with public education and targeted enforcement efforts, have the potential to greatly reduce the number of people seriously injured or killed on Sacramento's streets."[46]

[46] City of Sacramento, *Vision Zero Sacramento: Action Plan* (August 2018), https://www.cityofsacramento.org/-/media/Corporate/Files/Public-Works/Transportation/VisionZero/Vision-Zero-Action-Plan-Adopted-August-2018.pdf?la=en.

4. Institutionalize Equity in Road Safety Work

The focus on equity in roadway safety work is growing. Equity in transportation safety should include protecting populations that are traditionally underserved; a systemic approach ensuring safe and fair transportation options; and ensuring all road users have a safe route and access to basic community services regardless of age, income, or race. Consider the following American road safety statistics:

- American Indians and Alaska Natives are injured or killed in motor vehicle crashes at much higher rates than other Americans[47]
- The fatality rate for Hispanic bicyclists is 23 percent higher than for white bicyclists[48]
- Black people are twice as likely as white people to be killed while walking[49]

Institutionalizing equity in the SHSP process means embracing the Safe System principle that safety must be proactive—we must proactively work to address the inequities built into the current transportation system to keep vulnerable members of the community safe. An equitable transportation system is a key feature of a Safe System.

Equity refers to the fairness with which impacts—both benefits and costs—are distributed. Transportation equity means fairness within both the planning process and its outcomes, such as authentic engagement and resulting service improvements or infrastructure investments. Equity also extends to our individual perceptions about process and outcomes, and valuing those perceptions, particularly when voiced by populations that are traditionally underserved, including but not limited to individuals in at least one of the following categories:[50]

- Low-income
- Minority
- Elderly
- Children
- Limited English proficiency
- Persons with disabilities

[47] Centers for Disease Control and Prevention, "Tribal Road Safety," page last updated November 14, 2016, https://www.cdc.gov/features/tribalprograms/index.html.

[48] The League of American Bicyclists, *The New Majority,* retrieved from https://bikeleague.org/sites/default/files/equity_report.pdf.

[49] Safe Routes to School National Partnership, *At the Intersection of Active Transportation and Equity*, retrieved from https://www.saferoutespartnership.org/sites/default/files/resource_files/at-the-intersection-of-active-transportation-and-equity.pdf.

[50] FHWA, *Environmental Justice, Title VI, Non-Discrimination, and Equity*, retrieved from https://www.fhwa.dot.gov/environment/environmental_justice/equity/

Opportunities for States to address equity within the framework of SHSPs include:

- Clearly define equity in the SHSP and include equity considerations throughout the emphasis areas and strategies
- Incorporate equity considerations in implementation and assessment plans, such as goals related to safety improvements for populations that are traditionally underserved
- Investigate and document the impacts of traffic safety enforcement and traffic safety surveillance on minority communities
- Consider equity implications of traffic safety enforcement activities
- Develop restorative justice strategies to address harm done to traditionally underserved populations through road safety policies, programs, and disinvestment
- Meaningfully engage populations that are traditionally underserved in shared decision-making for the SHSP and subsequent safety programs, policies, or infrastructure projects
- Encourage or require local jurisdictions to engage traditionally underserved populations for HSIP infrastructure projects
- Encourage or require local jurisdictions to include equity metrics in project prioritization for HSIP
- Develop and implement strategies for robust demographic data collection in crash reporting, and include summaries of these data in the SHSP
- Expand the focus and quality of the data we collect and how we analyze it (see the following section for additional detail)

Noteworthy Practice: State of New Jersey Includes Equity in SHSP

As part of its 2020 SHSP, the State of New Jersey included equity as one of the 5 E's of safety in addition to engineering, education, enforcement, and emergency medical services/emergency response. The following is from the New Jersey 2020 SHSP:

> "This plan prioritizes equity in highway safety. To this end, and for the first time, we created an emphasis area team that is dedicated to ensuring that all strategies and activities emanating from this plan fairly and equitably consider all users and communities, particularly those that are historically disadvantaged, such as minority populations, economically depressed communities, and those that are differently abled."[51]

5. Use Proactive Data Collection and Analysis Approaches to Address Equity Considerations

The data-driven approach of the SHSP does not have to end with crash data. Incorporating innovative data methods and a focus on identifying risk factors, such as roadway or contextual variables, can help support a proactive approach to data analysis and evaluation while also uncovering the potential for inequitable safety outcomes. Shifting the focus to data collection and analysis methods that are less

[51] New Jersey Department of Transportation, *New Jersey 2020 Strategic Highway Safety Plan*, retrieved from https://www.saferoadsforallnj.com/resources.

reliant solely on historic crash records helps to align with the Safe System principle that safety is proactive. Opportunities to highlight the proactive approach to address equity in the SHSP include:

- Connecting each emphasis area to roadway or contextual safety contributing factors, such as the disproportionate number of fatalities and serious injuries among pedestrians in communities of color,[52] and recognizing this specific factor for pedestrian crashes—higher rates of crashes in minority communities—where transportation system gaps (e.g., sidewalks/bike lanes/crossing opportunities) can help proactively inform recommendations of the SHSP.
- Using innovative data collection and analysis approaches, such as crowdsourcing or video detection data, to identify emphasis areas related to near misses or crashes previously unreported by vulnerable communities. FHWA can further explore opportunities for near-miss or other innovative data to be used to support SHSP data driven problem identification.
- Providing support from FHWA to help in standardizing these proactive data collection and analysis methodologies for States.

Noteworthy Practice: Innovative Data Analysis to Uncover Inequitable Safety Outcomes for Native Populations in Washington State

As part of its 2019 SHSP, Washington has included a section of safety outcomes within the Native American community.[53] By analyzing race and ethnicity crash data, the State found that American Indian and Alaska Native residents have, by far, the highest rate of traffic fatalities. By incorporating this analysis and evaluation into the State's identification of emphasis areas, Washington is able to structure a proactive approach to addressing these inequities.

Noteworthy Practice: SafeTREC Street Story Tool

Crash data are often incomplete and may include biases. By definition, near misses are not included in this data set. Crashes may go unreported for a variety of reasons. For example, members of vulnerable communities, such as undocumented immigrants, are increasingly reluctant to call police for help.[54] To combat issues of crash underreporting, looking beyond the crash data set can help to identify safety issues that may have otherwise been missed. The Street Story tool SafeTREC, developed by the University of California, Berkeley, is one of the options for gathering and analyzing additional data. Community members can use the tool to document locations where there are known safety issues, where people have experienced near misses, or where a crash happened but went unreported. Communities throughout California are using this tool to engage residents and collect this important data.

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[52] Safe Routes to School National Partnership, *At the Intersection of Active Transportation and Equity*, retrieved from https://www.saferoutespartnership.org/sites/default/files/resource_files/at-the-intersection-of-active-transportation-and-equity.pdf.

[53] Washington Traffic Safety Commission, *Washington State Strategic Highway Safety Plan 2019* (2019), 126, http://targetzero.com/wp-content/uploads/2020/03/TargetZero2019_Lo-Res.pdf.

[54] American Civil Liberties Union, *Freezing Out Justice* (2018), https://www.aclu.org/report/freezing-out-justice.

Summary

This chapter outlined the following opportunities for aligning the State SHSP with the Safe System approach:

1. Organize the SHSP around Safe System six core principles and five elements
2. Commit to a "zero" goal and establish performance management strategies
3. Refocus speeding emphasis area on speed management and roadway design
4. Institutionalize equity in road safety work
5. Use proactive data collection and analysis approaches to address equity considerations

These opportunities represent initial steps that FHWA, States, and their partners can take to strengthen commitments to Safe System principles, with a particular emphasis on eliminating fatal and serious injury crashes through renewed emphasis on safe speeds and an equitable approach. The opportunities to organize future SHSPs around the Safe System approach can help to support and advance the other three opportunities.

Federal, State, and local partners responsible for roadway safety can consider the following questions, where applicable, as a first step to identify State-specific opportunities to move toward a Safe System through the SHSP:

- Does my State's SHSP recognize the Safe System approach?
- How do the emphasis areas within my State's SHSP align with Safe System elements and principles?
- Are there opportunities to strengthen the language used in my State's SHSP vision or goal to address elimination of fatalities and serious injuries?
- Will the SHSP strategies and actions help us reach our long-term safety goals?
- What performance management strategies can we implement to hold ourselves accountable for achieving our goals?
- Is my State or jurisdiction focused more on speeding rather than designing roadways for safe speeds?
- Is my State or jurisdiction addressing equity considerations in our safety planning efforts?

The following chapter explores opportunities for aligning State HSIPs with the Safe System approach.

Integrating Safe System with State HSIPs

Overview

The foundation of each State's HSIP is a roadway safety management (RSM) process, which includes:

- Problem identification
- Countermeasure identification (includes diagnosis, countermeasure selection, and economic appraisal)
- Project prioritization
- Evaluation

According to FHWA's *Highway Safety Improvement Program Manual*, "The SHSP influences decisions made during each step of the State HSIP process."[55] Thus, emphasis areas and strategies defined in the SHSP inform development and selection of viable safety projects in the State's HSIP process. These projects include infrastructure countermeasures that are strategies in the SHSP. The results of implementing and evaluating the HSIP in turn inform future SHSP and HSIP planning efforts. The graphic in figure 8 illustrates the relationship among the SHSP and HSIP.

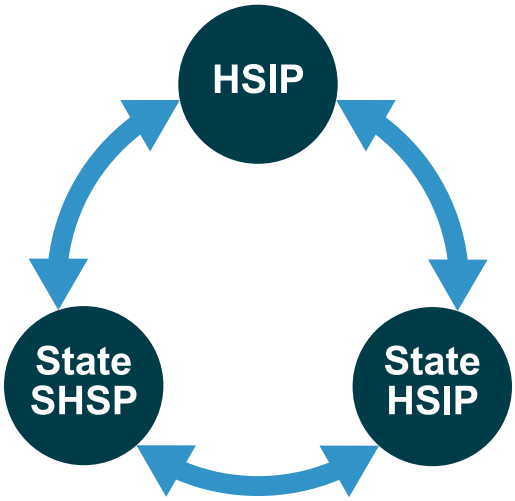

Figure 8. Illustration. Relationship among HSIP, State HSIP, and State SHSP. (Source: FHWA)

[55] FHWA, *Highway Safety Improvement Program Manual*, FHWA-SA-09-029 (January 2010), 1–11, https://safety.fhwa.dot.gov/hsip/resources/fhwasa09029/fhwasa09029.pdf.

Within the parameters laid out by the HSIP regulation, States develop their own processes for planning, implementing, and evaluating highway safety improvement projects (23 CFR Part 924.7).

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA–LU) (119 Stat. 1144 Pub. L. 109–59, August 10, 2005) switched the focus of the Federal safety program to reducing fatalities and serious injuries. The scope of States' safety programs changed as a result of this switch. In addition to reactive improvements at high crash locations, some States introduced proactive improvements based on the presence of factors believed to contribute to crash occurrence or injury severity levels at other like locations (the systemic approach to safety).

The following sections demonstrate how the State HSIP process aligns with Safe System principles, as well as opportunities and noteworthy practices to advance implementation of Safe System in the States' HSIP.

Alignment of Safe System Principles with Major State HSIP Features

The RSM aspect of the State HSIP program forms a strong basis from which to integrate the Safe System approach, as an RSM is a primary component of implementing Safe System in other countries. As shown in table 3, most steps in the HSIP process are somewhat aligned with Safe System principles.

Table 3. Safe System alignment with State HSIP major program features.

Problem Identification Safety programs and projects are based on a robust, data-driven process, based on historic crash patterns and a proactive assessment of the factors with the potential to lead to future crashes.		
Safe System Principle	**Alignment**	**Rationale**
Death/Serious Injury Is Unacceptable	◑	While some States focus on fatal and serious injury crashes for network screening, this practice is not consistent across all States. A primary reason is because many predictive methods (e.g., safety performance functions) are focused on total crashes, not fatal and serious injury crashes. Additionally, some States are fortunate to have a small number of fatal and serious injury crashes, creating sample size issues.
Humans Make Mistakes	◑	The HSIP problem identification approach can uncover roadway safety issues related to human mistakes, but planning for human mistakes is not inherent in this program feature.
Humans Are Vulnerable	◑	The HSIP problem identification approach can uncover roadway safety issues related to human vulnerability, but addressing vulnerability is not inherent in this program feature.
Responsibility Is Shared	○	Problem identification under the current HSIP process does not necessitate shared responsibility.

Safe System Principle	Alignment	Rationale
Safety Is Proactive	◑	Most States use systemic analysis and implementation methods to widely deploy improvements based on roadway features that analysis has shown in similar situations are contributing to specific serious crash types, even though the location may not currently have a location-specific crash history. Supplementing traditional analyses with systemic techniques is consistent with the Safe System approach described in this report. The systemic approach has both reactive and proactive components, and it should be used in addition to the hot-spot approach.
Redundancy Is Crucial	◯	Problem identification under the current HSIP process does not necessitate a redundant system.

● Full Alignment ◑ Partial Alignment ◯ Minimal Alignment/Not Applicable

Countermeasure Identification Identify proven safety countermeasures that address the specific crash patterns and factors present, with a focus on reducing fatal and serious injury crashes.		
Safe System Principle	**Alignment**	**Rationale**
Death/Serious Injury Is Unacceptable	◑	Targeting fatal and serious injury crashes with countermeasure solutions is central to the development of a Safe System and the State HSIP. While most States use crash modification factors (CMFs) to assess the expected benefits of potential countermeasures, there are limited CMFs available for fatal and serious injury crashes.
Humans Make Mistakes	◑	According to the International Transport Forum, in the behavioral approach, human error is seen as the primary cause of traffic crashes.[56] A very different view emerges when crashes are investigated from a Safe System lens in which the needs, limitations, and capacities of the road users are integrated in the traffic system. While human factors should be a primary factor in countermeasure identification, it is not consistently applied across the States.
Humans Are Vulnerable	●	Continuing research to support development of CMFs for countermeasures focused on vulnerable road users is key to ensure that safety projects addressing vulnerable users are funded and implemented. It is also important that roadsides are adequately protected, and speeds managed for the benefit all road users, rather than at the expense of some.
Responsibility Is Shared	◑	Responsibility for countermeasure identification, implementation, funding, management, and maintenance can be shared by everyone responsible for roadway safety, but shared responsibility is not inherent in this program feature.
Safety Is Proactive	◑	Countermeasures can be identified through a proactive process that relies on systemic analysis, but countermeasures can also be identified through a reactive process.
Redundancy Is Crucial	◑	Countermeasure identification can focus on redundancy in the transportation system, but it is not a required component of this program feature. Additional redundancy can be introduced into countermeasure selection and prioritization steps of the HSIP process.

● Full Alignment ◑ Partial Alignment ○ Minimal Alignment/Not Applicable

[56] ITF, *Zero Road Deaths and Serious Injuries* (2016), http://www.towardszerofoundation.org/wp-content/uploads/2016/10/Zero_road_deaths-SafeSystems.pdf.

Project Prioritization Prioritization methods include benefit/cost analysis, ranking, and optimization approaches.		
Safe System Principle	**Alignment**	**Rationale**
Death/Serious Injury Is Unacceptable	◑	Many States use benefit-cost analysis that focus on all crashes, not just fatal and serious injury crashes. There is limited research and data to support countermeasure efficacy focused on the most severe crashes, so this limits a State's ability to include only fatal and serious injury crashes in benefit-cost analysis.
Humans Make Mistakes	◑	Projects can be prioritized based on how well they incorporate the assumption of human mistakes, but this is not mandated as part of the HSIP process.
Humans Are Vulnerable	◑	Projects can be prioritized based on how well they account for human vulnerability. For example, fatal and serious injury crashes are weighted more heavily than other crashes in the benefit-cost analysis. However, CMFs—another key component of the benefit-cost analysis—often account for all crashes, including property damage crashes where human vulnerability is not a factor.
Responsibility Is Shared	◑	Projects can be prioritized based on how well they incorporate shared responsibility for roadway safety, but this is not mandated as part of the HSIP process.
Safety Is Proactive	◑	It can be challenging for agencies to prioritize systemic projects using benefit cost analysis due to lack of crash history.
Redundancy Is Crucial	◑	Projects can be prioritized based on how well they incorporate system redundancy, but it is not mandated as part of the HSIP process.

● Full Alignment ◑ Partial Alignment ○ Minimal Alignment/Not Applicable

Evaluation

The evaluation process reveals if the overall program has been successful in reaching performance goals established in the planning process, including its effectiveness in reducing the number of fatalities and serious injuries.

Safe System Principle	Alignment	Rationale
Death/Serious Injury Is Unacceptable	●	Evaluation focuses on benchmarking against safety targets specific to fatalities and serious injuries. However, while many States have advanced in this area over the past 10 years, opportunities remain for States to do more and better evaluation.
Humans Make Mistakes	○	Human error is not a component in the evaluation process.
Humans Are Vulnerable	○	Human vulnerability is not a component in the evaluation process.
Responsibility Is Shared	◑	Responsibility for evaluating countermeasure and strategy success can be shared across many different parties responsible for roadway safety, but shared responsibility is not inherent in this program feature.
Safety Is Proactive	◑	Valuable insights gained in the evaluation process are fed back into the road safety decision-making process to allow for proactive roadway safety changes.
Redundancy Is Crucial	◑	Evaluation of the States' HSIP to assess redundancy can be part of this program feature, but is not explicitly stated as a key component.

● Full Alignment ◑ Partial Alignment ○ Minimal Alignment/Not Applicable

Collectively, the State HSIP major program features partially address each of the Safe System principles. Specifically, HSIP evaluation fully addresses the principle that *Deaths and Serious Injuries Are Unacceptable*, and HSIP countermeasure identification fully addresses the principle that *Humans Are Vulnerable*. Problem identification does not directly address *Responsibility Is Shared* or *Redundancy Is Crucial*, but the HSIP does address these principles later in the process as States identify potential solutions to address the problem locations. Similarly, HSIP evaluation does not directly address the Safe System principles that *Human Make Mistakes* or *Humans Are Vulnerable;* however, if these principles were addressed earlier in the HSIP process then it will be reflected in the safety performance outcomes. While partial alignment with the Safe System principles is a step in the right direction, there are additional opportunities to further integrate the Safe System principles in the States' HSIPs.

Opportunities and Noteworthy Practices

The following opportunities and noteworthy practices illustrate key considerations that can enable practitioners to holistically integrate the Safe System approach into the State HSIP.

1. Research, Prioritize, and Fund Engineering Countermeasures That Address Safe System Elements and Principles

1A. Hierarchy of Controls

The States and FHWA, through the HSIP, can evaluate and prioritize countermeasures that align with Safe System principles. Using the Hierarchy of Controls, shown in figure 9, as a framework, the countermeasures most aligned with the Safe System principle to eliminate death and serious injury would fall within the Elimination category, with the aim of physically removing the roadway safety hazard.[57] These countermeasures should be prioritized for implementation first. Through updated research available in the CMF Clearinghouse, FHWA could support States in performing evaluations to identify countermeasures that fall within this Elimination category.[58]

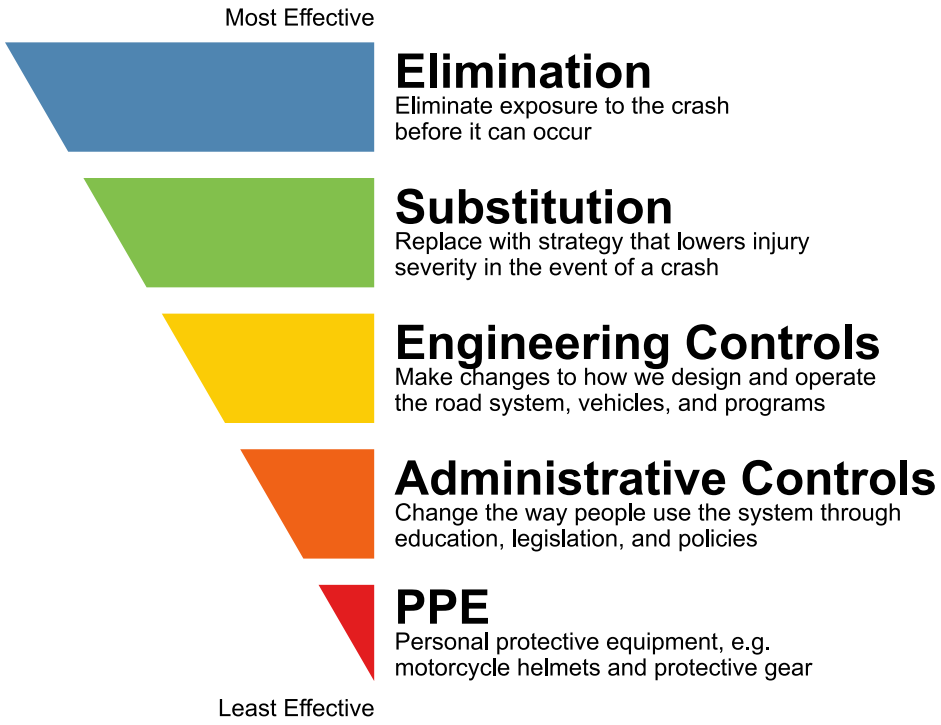

Figure 9. Illustration. Hierarchy of Controls for Traffic Safety.
(Source: Washington Traffic Safety Commission)

[57] Washington Traffic Safety Commission, *Washington State Strategic Highway Safety Plan 2019*, http://targetzero.com/wp-content/uploads/2020/03/TargetZero2019_Lo-Res.pdf.
[58] FHWA, Crash Modification Clearinghouse, CMFs last added August 14, 2020, http://www.cmfclearinghouse.org/.

Noteworthy Practice: Australia Assesses Countermeasures for Alignment with Safe System Principles

In its report, *The Safe System Hierarchy of Control Framework for Local Roads*, for the 2016 Australasian Road Safety Conference, the Australian Road Research Board (ARRB) Group proposed a framework for evaluating countermeasures under the Hierarchy of Controls, as shown in Table 4.[59] This concept placed an emphasis on removing the roadway safety hazard, in alignment with the Safe System principle of eliminating deaths and serious injury.

Table 4. Australia Hierarchy of Control Countermeasure Framework. (Source: ARRB Group)

Hierarchy	Risk Control Method	Effect of Control	Example
1	Remove the risk	Remove the hazard from the road and traffic environment	• Remove a tree or utility pole from the roadside area • Grade separated pedestrian crossings • Fully separated cycleway
2	Reduce the risk	Replace one hazard with another, less severe and more controllable, hazard Physically separate road users from the hazard to minimize road user interaction with it, or modify the design of the road infrastructure to reduce road user interaction with the hazard and/or assist road user control	• Road safety barrier • Roundabout (replacing priority controlled cross or T-intersection) • Wide median or verge area with or without a safety barrier • Traffic signal control pedestrian crossings • Off-road cycleway • Increase lane and sealed shoulder width • Improve delineation of the carriageway • Provide pedestrian crossing with refuge island • On-road cycleway and shared zones • Improve the Australian New Car Assessment Program (ANCAP) rating of vehicle fleet
3	Change road user behavior	Provide warning/advice to seek appropriate behavior	• Curve warning/speed advisory signs • Reduced speed limit and school zone alert signing • Vehicle safety features such as speed alerts, lane departure warning, blind-spot monitoring, etc. • Enforcement, education, and training
4	Protect the road user	Use equipment to protect users from death/injury	• Seat belts, anti-lock braking system (ABS), electronic stability control (ESC), automatic emergency braking (AEB) • Pedestrian airbags and bonnet designs • Replace a rigid lighting pole with a frangible pole

[59] D. McTiernan and A. Rensen, "The Safe System Hierarchy of Control Framework for Local Roads," in *Australasian Road Safety Conference* (Canberra, ACT, Australia: September 2016).

1B. Primary and Supporting Countermeasures

Within the Hierarchy of Controls framework, Australia also defines primary and supportive road safety treatments. There is an opportunity for packages of countermeasures to be considered together in project prioritization, allowing for primary and supporting countermeasures to be prioritized on the basis of introducing redundancy. Primary treatments represent an important step toward a Safe System, and supportive treatments provide incremental safety gains but not to a level that would create a Safe System.[60] Defining a priority list of Safe System strategies that fits within the Hierarchy of Controls and falls within a primary or supporting countermeasure category could be a useful tool to support HSIP countermeasure identification and project prioritization.

Noteworthy Practice: Australia Categorizes Countermeasures as Primary and Supporting

In its *Safe System Roads for Local Government* report, Austroads proposed a framework for evaluating countermeasures as either primary for supporting a Safe System and achieving zero death and serious injuries, or as supporting that approach.[61] Table 5 highlights primary and supporting countermeasures for reducing speeds at intersections.

Table 5. Australia primary and supporting countermeasure framework. (Source: ARRB Group)

Treatment		Type	Road Environment	Expected Costs	Safe Speeds	Safe Roads and Roadsides	Safe Road Users	Safe Vehicles	Innovative (New Concept in Australia)
Primary	Installing roundabout	Speed reduction/ crash severity	Urban/rural	$$$	✓	✓			
Supporting	Speed cameras	Enforcement	Urban/rural	$$	✓	✓			
	Intersection raised platforms	Speed reduction	Urban	$$	✓	✓			
	Turn to red if speeding	Enforcement/ speed reduction	Urban/rural	$	✓	✓			✓
	Rest-on-red	Separation/ speed reduction	Urban	$	✓	✓			✓

[60] Austroads, *Safe System Roads for Local Government* (April 2106), https://austroads.com.au/publications/road-safety/ap-r518-16/media/AP-R518-16_Safe_System_Roads_for_Local_Government.pdf.

[61] Austroads, Safe System Roads for Local Government (2016).

Treatment		Type	Road Environment	Expected Costs	Safe Speeds	Safe Roads and Roadsides	Safe Road Users	Safe Vehicles	Innovative (New Concept in Australia)
	Transverse rumble strips	Speed reduction	Urban/rural	$	✓	✓	✓		✓
	Restriction of sight distance	Speed reduction	Urban/rural	$	✓	✓			✓
	Decrease in speed limit unrestricted to a speed limit 100-80 km/h 80-60 km/h 60-50 km/h	Speed reduction	Urban/rural	$	✓	✓	✓		

1C. Beyond Traditional Countermeasures

Although the HSIP program focuses on engineering, all five Safe System elements (i.e., safe roads, safe vehicles, safe speeds, safe road users, and post-crash care) and the Safe System principles can be integrated more holistically. Because none of these elements are sufficient on their own, the entire transportation network becomes safer when they are taken into consideration and implemented as a whole. Each State HSIP should address Safe System elements and principles in a coordinated and systemic manner, and not in silos. This can be accomplished by broadening the focus of engineering countermeasures to include roadway design or control elements that specifically support each Safe System element. This approach looks to provide a buffer or redundancy in the system that can reduce the level of severity when a crash does occur. For example, engineering countermeasures can be identified that influence behavior change and account for human limitations, prioritize emergency response for timely and high-quality post-crash care, and provide supportive infrastructure for safer connected and autonomous vehicles.

There are additional opportunities to incorporate human factor research (i.e., applying psychological and physiological principles to engineering and design) into the problem identification process. States can consider using equity considerations in project prioritization through the HSIP, with a change to benefit-cost analysis or through a set-aside program.

Changing countermeasure evaluation methods to primarily focus on fatal and serious injury crash reduction opportunities can help refocus this evaluation system on the Safe System principle that deaths and serious injuries are unacceptable. This same approach could be applied to network screening methodologies and benefit/cost ratio calculations, because including only the most serious injury crashes may result in a project prioritization different from when all crashes are factored in the calculation. It is also important to consider the role of vehicle safety advancements, like backup cameras and blind spot monitoring sensors, in shaping the severity of crashes. Due to these advancements, we may see shifting

patterns in the most severe collisions, pointing to the importance of the systemic approach to analysis where the highest risk roadway and contextual factors are identified.

Below are examples of how to integrate Safe System principles and elements into countermeasure selection:

- Humans make mistakes: This principle assumes people will make mistakes; therefore, the transportation system should be designed to minimize the opportunity for mistakes and also to be forgiving so that mistakes do not lead to fatal outcomes. The HSIP should identify opportunities to lessen the opportunity for road users to make mistakes (e.g. intersection designs that reduce conflict points), as well as incorporate shared responsibility and design redundancy in the system to prevent crashes. This principle is currently integrated into some road infrastructure safety strategies, such as roadway departure, but should be done systemically and by understanding crash causation to achieve a Safe System approach. The first priority to avoid roadway departures is to keep vehicles on the road. Once vehicles have left the travel lane, the second priority is to provide an opportunity for the vehicle to safely reenter the travel way (i.e., safe recovery.) And lastly, the goal is to minimize the severity if roadway departure crashes do occur.
- Safe vehicles: Accelerating technology means carefully embracing and promoting technical innovations that can help us get "smarter"—in tech-speak—when it comes to safety. Within the context of the HSIP, this includes infrastructure for smarter roadways and intelligent transportation systems (ITS) and more robust safety data collection and analysis.

  As State and local jurisdictions are already host to autonomous vehicle pilot programs, and autonomous features are present in an ever-growing share of the vehicle fleet, agencies should now prepare for and begin adapting these new technologies. States can consider widespread adoption of these technologies through updated SHSPs, as well as implementation of CV or autonomous vehicle infrastructure—from upgrading to wider and brighter lane striping to ITS investments. Data about the involvement of AVs in crashes can also be collected in crash reports and used for future data analysis.

Noteworthy Practice: California and Washington Include "Emerging Technologies" in SHSP

In California's 2020 SHSP, emerging technologies is one of the safety E's. Under this emphasis area, the State focuses on six key examples of ways technology could be used to reduce fatal and serious injury crashes:

- Alerting drivers at risk
- Assisting drivers at risk
- Protecting vehicle occupants
- Communicating with drivers and the environment, including vulnerable road users outside the vehicle
- Vehicle performing as designed
- Mobile technology and applications focused on behavior change[62]

In Washington, the 2019 SHSP includes a "Cooperative Automated Transportation" section, which focuses on strategies around data collection and assessment of AV-supportive engineering changes, such as:

- Incorporate AV information into traffic violation and crash reports, including level, operational design domain (ODD), and if the vehicle was under driver or vehicle control.
- Assess infrastructure elements, such as signing and striping and the potential need for roadside communication equipment, so that they are conducive to enabling and supporting the operation of AVs.[63]

1D. Prioritize Research for Countermeasures Focused on Bicycle and Pedestrian Safety

According to national trends, crashes with vulnerable road users have been increasing,[64] and these crashes are over-represented for minority and low income populations (low-income is defined as an annual per capita income of less than $21,559 for the purposes of this report).[65,66] This is an equity and racial justice concern, because these types of crashes have a disproportionate impact on communities that have experienced public disinvestment as the transportation system is often incomplete with road systems

[62] Caltrans, *Strategic Highway Safety Plan*, 58, retrieved from https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/safety/shsp/2020-2024-shsp-report.pdf.

[63] Washington Traffic Safety Commission, *Washington State Strategic Highway Safety Plan 2019* (2019), 190–191, http://targetzero.com/wp-content/uploads/2020/03/TargetZero2019_Lo-Res.pdf.

[64] NHTSA, "Traffic Safety Facts Annual Report Tables," last updated June 30, 2020, https://cdan.nhtsa.gov/tsftables/tsfar.htm.

[65] Safe Routes to School National Partnership, *At the Intersection of Active Transportation and Equity*, retrieved from https://www.saferoutespartnership.org/sites/default/files/resource_files/at-the-intersection-of-active-transportation-and-equity.pdf.

[66] M. Maciag, "Pedestrians Dying at Disproportionate Rates in America's Poorer Neighborhoods" (August 2014), *Governing* magazine, https://www.governing.com/topics/public-justice-safety/gov-pedestrian-deaths-analysis.html.

that have a higher potential for crashes.[67] However, the toolbox of effective countermeasures for pedestrian and bicycle safety continues to be limited. A recent Transportation Research Board (TRB) research effort describes "the lack of quality crash data (frequency, severity, injury patterns, contributing factors, crash types) and exposure data (volume, severity, and event data) for different contexts."[68]

Research that supports effectiveness evaluations of safety countermeasures should continue to evolve and inform updates to HSIP-eligible project lists. Continuing to incorporate national studies, such as the recent NTSB *Bicyclist Safety on US Roadways: Crash Risks and Countermeasures*[69] report, into the States' SHSP and HSIP can help cross-agency alignment and support evolving safety infrastructure norms within the State and local context. Without updated safety effectiveness research to support countermeasures like separated or protected bikeways, these projects may not be prioritized under the current data-driven HSIP process and may limit their systemic application. Research can address topics such as geometric design criteria impacts on pedestrian and bicyclist exposure to crashes, as well as address kinetic energy transfer in crashes through countermeasures. Additional and more robust bicycle and pedestrian data collection efforts and volume prediction models would also provide needed data to support countermeasure research.

There is an opportunity for packages of countermeasures to be considered together in project prioritization, allowing primary and supporting countermeasures to be prioritized based on introducing redundancy.

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[67] Safe Routes to School National Partnership, *At the Intersection of Active Transportation and Equity*, retrieved from https://www.saferoutespartnership.org/sites/default/files/resource_files/at-the-intersection-of-active-transportation-and-equity.pdf.

[68] National Cooperative Highway Research Program, *Pedestrian and Bicycle Safety Performance Functions for the Highway Safety Manual*, paragraph 1, retrieved from https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4203.

[69] National Transportation Safety Board, *Bicyclist Safety on US Roadways: Crash Risks and Countermeasures* (November 2019), https://www.ntsb.gov/safety/safety-studies/Documents/SS1901.pdf.

Noteworthy Practice: Washington SHSP Makes Connection between Vulnerable Road Users and Speed Management Countermeasures

Washington prioritizes countermeasures for speed management as key strategies to change crash severity outcomes for vulnerable users such as pedestrians and bicyclists. The SHSP states:

- Although it has emerged at the national level as an essential strategy, the practice of setting and designing speed limits to minimize injuries and fatalities for pedestrians and bicyclists is relatively new for Washington State.[70]
- To achieve Target Zero, partners must prioritize self-enforcing speed reduction countermeasures wherever pedestrians, bicyclists, and motorists are likely to interact on the roadway.[71]
- Many Safe System improvements focus on vulnerable road users such as pedestrians and bicyclists. The good news is that designing to reduce exposure to potentially fatal crashes for the most vulnerable road users is a proven, effective strategy to achieve better outcomes for motorists and motorcyclists as well.[72]

1E. Doubling Down on Countermeasures to Address Fatal and Serious Injury Crashes

Across all aspects of the HSIP process, States can double down on prioritizing countermeasures that address fatal and serious injury crashes. Changes can include the following:

- Conduct CMF research that specifically focuses on fatal and serious injury crashes
- Develop safety performance functions specifically for fatal and serious injury crashes
- Include only fatal and serious injury crashes in the network screening process to identify key safety issues

Shifting focus to fatal and serious injury crashes also allows for human vulnerability and human factors to take on a more prominent role in roadway safety research. As a result of this change in program focus, the scope of States' safety programs has also changed. In addition to reactive improvements at high crash locations, States are also introducing proactive improvements based on the presence of risk factors (systemic approach to safety), which aligns with the Safe System principle that *Safety Is Proactive*. However, the focus on fatalities and serious injuries has not carried through to all aspects of every State's safety program.

Programs like usRAP, which is a proactive risk assessment that includes an international star rating system (through iRAP), are already proven in creating increased transportation safety. These programs collect and provide key roadway and traffic control data to highway agencies to support proactive safety analysis,

[70] Washington Traffic Safety Commission, *Washington State Strategic Highway Safety Plan 2019* (2019), 126, http://targetzero.com/wp-content/uploads/2020/03/TargetZero2019_Lo-Res.pdf.
[71] Washington Traffic Safety Commission, *Washington State Strategic Highway Safety Plan 2019* (2019), 127.
[72] Washington Traffic Safety Commission, *Washington State Strategic Highway Safety Plan 2019* (2019), 194.

which can help to further align problem identification processes with the Safe System approach. Enhancements to usRAP could include incorporating KPIs, for example, similar to the *EU Road Safety Policy Framework 2021-2030*.[73]

> ***Noteworthy Practice: Arizona Keeps Focus on Fatal and Serious Injury Crashes***
> The Safe System approach puts fatal and serious injury crashes at the forefront. In cases where fatal or serious injury crash reduction data may not be available, other options may be considered. For example, Arizona's HSIP promotes identifying effective countermeasures that focus on the "expected reduction in the number of fatalities and serious injuries,"[74] including only the most severe crashes in the HSIP application benefit/cost ratio calculation. The State publishes CMFs for fatalities and serious injuries when possible. However, if sufficient data on fatal and serious injury crashes are not available, the State will also include CMFs related to minor injuries.[75]

1F. Other Project Prioritization Considerations

Given these different options for identifying countermeasures that support a Safe System approach, it is reasonable to ask whether or not benefit-cost analysis will continue to be the right approach for identifying and prioritizing highway safety improvement projects. Should we turn our focus from the most cost-effective countermeasures to instead prioritize the most effective countermeasures? According to the International Transport Forum, "Financing road safety is also viewed from a new angle in a Safe System. In a traditional approach, the main question related to financing is, 'Which measures are most effective, given the available budget for improving road safety?' In the case of working towards a Safe System, the question should be, 'How much money do we need to create a Safe System and how do we get the necessary funding?'"[76] The former description fits the current system of benefit-cost analysis, confirming that enhancements to this current system are necessary to achieve a paradigm shift under Safe System.

States and FHWA can work together to determine the right approach for prioritizing funding for projects under a Safe System approach. For example, States can consider using equity considerations in project prioritization through the HSIP, with a change to benefit-cost analysis or through a set-aside program. Setting priorities may also leverage backcasting, which identifies the infrastructure and funding required to achieve zero traffic deaths in a future horizon year, and then sets interim funding, policy, and program milestones between the current year and horizon year.

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[73] European Commission, *EU Road Safety Policy Framework* (2019), https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/1_en_document_travail_service_part1_v2.pdf.
[74] Arizona Department of Transportation (ADOT), *Arizona Highway Safety Improvement Program Manual* (2018), 12, https://azdot.gov/sites/default/files/2019/06/2015-hsip-manual.pdf.
[75] ADOT, *Arizona Highway Safety Improvement Program Manual* (2018), appendix B, https://azdot.gov/sites/default/files/2019/06/hsip-appendixB.pdf.
[76] ITF, *Zero Road Deaths and Serious Injuries* (2016), 38, http://www.towardszerofoundation.org/wp-content/uploads/2016/10/Zero_road_deaths-SafeSystems.pdf.

Research should be conducted to broaden the focus of engineering countermeasures to include roadway design or control elements that specifically support each Safe System element. For example, engineering countermeasures can be identified that influence behavior change and account for human limitations, prioritize emergency response for timely and high-quality post-crash care, and provide supportive infrastructure for safer connected and autonomous vehicles. Research should also identify how kinetic energy models can help States identify and prioritize projects. Lastly, research could compare CMFs versus kinetic energy models and develop guidance on how to blend those two approaches and analytics.

Noteworthy Practice: California's Pedestrian Safety Improvement Monitoring Program and Virginia's Pedestrian Safety Action Plan

In its Pedestrian Safety Improvement Monitoring Program[77] (round 2), California developed an initial systemic list of locations from crash data patterns in each district, then applied a prioritization process to sort the locations for the most pressing need for intervention. This process included weighting the presence of a crash heavily in importance, but several other variables were included to prioritize for children, seniors, and equity concerns for disadvantaged communities.

Similarly, in 2019 the Virginia Department of Transportation updated the priority locations for pedestrian safety improvements as part of its Pedestrian Safety Action Plan[78] with location prioritization that included the Virginia Department of Health's Health Opportunity index (HOI) composite score. The score comprises factors such as food accessibility and income inequality. Including the HOI in the location prioritization methodology embeds equity considerations in the process.

2. Assess Crash Severity Risk Using Level of Kinetic Energy Transfer and Speed

Risk of serious injury crashes may be proactively estimated across both the State and local road networks using relationships between the operating speeds and roadway characteristics and features. Proactive risk estimation processes may be applied that are similar to the network screening of potential risk factors under a systemic safety approach. As HSIP programs evolve to blend proactive systemic safety processes with reactive approaches based on historic crashes, agencies can progressively move toward integrating an estimation of the likelihood of future severe crash outcomes for their road networks. Shifting the focus to speed and kinetic energy transfer helps to align with the Safe System principle that *Humans Are Vulnerable*.

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[77] Caltrans, *2016 Pilot Pedestrian Collision Monitoring Program*, retrieved from https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/ped-bike/f0018144-2016-pilot-pedestrian-collision-monitoring-program-fact-sheet-version-1-a11y.pdf.

[78] Virginia Department of Transportation, 2019 Pedestrian Safety Action Plan Analysis Update - User Guide (December 2019).

Throughout FHWA's HSIP and SHSP documentation, language can be included that draws a direct connection between human body tolerance, speed, kinetic energy transfer, and crash severity. This could include references to roadside safety hardware and crash testing specifically focused on kinetic energy transfer, as well as crash reconstruction methods used by agencies and the NTSB.[79]

Understanding kinetic energy transfer (e.g., crash magnitude) related to different modes, crash types, and roadway conditions could help States identify and prioritize projects. In a call for action in the *Journal of Injury and Violence Research*, Davoud Khorasani-Zavareh and his coauthors state, "Road traffic injury preventive activities necessitate Kinetic energy management to improve road user safety."[80]

Additional research on this topic is needed to help support an agency's project prioritization efforts, including how kinetic energy models can be used to complement or supplement crash prediction models. This research need has been recognized by road safety experts across the United States, and studies such as the forthcoming FHWA *Establishing a Safe System Framework for Intersections*[81] will begin to address this need. Through Federal and State research, agencies could review existing crash data records to estimate the crash magnitude, in terms of kinetic energy, that was carried by involved parties prior to the crashes. After determining the range of kinetic energy magnitudes across the State for different modes and conditions, States could make safety intervention and prioritize decisions with this in mind. This work could be performed through the National Cooperative Highway Research Program (NCHRP) or as a pooled-fund study.

[79] FHWA, Crash Investigation and Reconstruction Technologies and Best Practices, FHWA-HOP-16-009 (October 2015).

[80] Davoud Khorasani-Zavareh et al., "Kinetic Energy Management in Road Traffic Injury Prevention: A Call for Action," *Journal of Injury and Violence Research* 7.1 (2015): 36.

[81] FHWA (forthcoming), Establishing a Safe System Framework for Intersections.

Noteworthy Practice: Australia's Focus on Kinetic Energy Transfer

Australia's roadway safety strategies are built on the foundation of Safe System principles and include a focus on kinetic energy transfer. For example, crash severity levels are defined using kinetic energy transfer concepts, with the following two extremes:[82]

- 0 = should a crash occur, there is only minimal chance it will result in a fatality or serious injury to the relevant road user. This might mean that kinetic energy transferred during the crash is low enough to not cause a fatal or serious injury (FSI), or that excessive kinetic energy is effectively redirected/dissipated before being transferred to the road user.[83]
- 4 = should a crash occur, it is highly likely it will result in a fatality or serious injury to any road user. Kinetic energy is high enough to cause a FSI crash, and it is unlikely that the forces will be dissipated before reaching the road user.[84]

In its project-level countermeasure assessment process, Australia uses these definitions of likely crash severity, along with crash likelihood and road user exposure, to score different countermeasures based on alignment with the Safe System and then prioritize new infrastructure appropriately.

The FHWA has a study underway, entitled *Establishing a Safe System Framework for Intersections*,[85] which supports this recommendation. This study will present a methodology that explicitly incorporates Safe System principles to vet different intersection design and control alternatives. The methodology will be sensitive to exposure, severity, and complexity, and will rely on inputs commonly available during project development. This initial framework will dovetail with the first stage of intersection control evaluation procedures, which is typically the planning or scoping stage of an intersection project.

3. Identify Opportunities to Encourage Local Planning Efforts That Align with the Safe System Approach

In alignment with State SHSP and HSIP goals, States can provide funding for and encourage local jurisdictions to undertake their own safety planning efforts that align with the Safe System approach. In States with competitive HSIP grant programs, these planning efforts can also set cities and counties up for success in HSIP grant applications. At the State level, an updated SHSP that incorporates Safe System principles could act as a key resource for local jurisdictions interested in this approach. This approach aligns with the Safe System principle that *Responsibility Is Shared*.

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[82] Austroads, *Safe System Infrastructure on Mixed Use Arterials* (2017), https://austroads.com.au/publications/road-safety/ap-t330-17/media/AP-T330-17_Safe_System_Infrastructure_on_Mixed_Use_Arterials.pdf.
[83] Austroads, Safe System Infrastructure on Mixed Use Arterials (2017), 120.
[84] Austroads, Safe System Infrastructure on Mixed Use Arterials (2017), 121.
[85] FHWA (forthcoming), Establishing a Safe System Framework for Intersections.

Noteworthy Practice: Local Jurisdictions Embracing Holistic Safety Planning Efforts

San Francisco, one of the early adopters of the Vision Zero approach to road safety, has been embracing the Safe System principles for many years, demonstrating how the Safe System approach can be brought to the local level. The core tenants of Vision Zero align with that of the Safe System approach, and San Francisco has implemented their program with a focus on important elements such as post-crash care, forging important relationships with the San Francisco General Hospital and Trauma Center "to develop a comprehensive system to ensure accurate, coordinated and timely monitoring of injuries and fatalities for safety project prioritization, evaluation, and reporting."[86]

4. Establish Safe System Working Group and Pilot Projects

According to the International Transport Forum, "Demonstrations and pilot projects can also be helpful to raise awareness among road users, system designers and politicians that a Safe System improves road safety."[87] Commonly cited Safe System demonstration projects include Sweden's 2+1 Road Pilot, which is "a three-lane road with two lanes in one direction and one lane in the other that alternate every few kilometers, as an alternative to traditional motorways. The pilot project provided evidence for a positive safety effect of this concept and convinced road designers and engineers that this was an appropriate solution for the Swedish situation."[88]

To help establish and support demonstration projects, as well as develop resources for general support of transitioning to a Safe System approach, FHWA or individual State DOTs can establish a Safe System working group. Western Australia regional jurisdictions have established Safe System working groups.[89] This is an opportunity to encourage collaboration among Federal and State stakeholders in committing to an ongoing Safe System approach. Similar working groups could be established to encourage collaboration among State and local roadway safety representatives.

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[86] Vision Zero SF, "Evaluating & Monitoring Our Progress," retrieved from https://www.visionzerosf.org/vision-zero-in-action/evaluating-monitoring-our-progress/.

[87] ITF, *Zero Road Deaths and Serious Injuries* (2016), 45, http://www.towardszerofoundation.org/wp-content/uploads/2016/10/Zero_road_deaths-SafeSystems.pdf.

[88] ITF, *Zero Road Deaths and Serious Injuries* (2016), 45, http://www.towardszerofoundation.org/wp-content/uploads/2016/10/Zero_road_deaths-SafeSystems.pdf.

[89] ITF, *Zero Road Deaths and Serious Injuries* (2016), http://www.towardszerofoundation.org/wp-content/uploads/2016/10/Zero_road_deaths-SafeSystems.pdf.

Noteworthy Practice: Partnerships Lead to Innovation in Texas

In Texas where the majority of rural travel occurs on two-lane highways, it had become common practice for drivers to pull onto the shoulder to let a vehicle pass, creating potential safety issues.[90] The Texas A&M Transportation Institute (TTI) and the Texas DOT (TxDOT) partnered together to develop a solution—called the Super 2 design—where short-term passing lanes were installed at regular intervals along two-lane corridors. Since then, other States have followed suit, and TTI and TxDOT continue to partner together to research and refine this solution.

Summary

This chapter outlined the following opportunities for aligning the State HSIP process with the Safe System approach:

1. Research, prioritize, and fund engineering countermeasures that address Safe System elements and principles
    a. Hierarchy of Controls
    b. Primary and supporting countermeasures
    c. Beyond traditional countermeasures
    d. Prioritize research for countermeasures focused on bicycle and pedestrian safety
    e. Doubling down on countermeasures to address fatal and serious injury crashes
    f. Other project prioritization considerations
2. Assess crash severity risk using level of kinetic energy transfer and speed
3. Identify opportunities to encourage local planning efforts that align with the Safe System approach
4. Establish Safe System working group and pilot projects

These opportunities are primarily organized around research, prioritization, and funding of countermeasures, which are key to the HSIP process. By refocusing countermeasure research, prioritization, and funding on key components of the Safe System approach such as eliminating risk, incorporating redundancy, and recognizing human vulnerability, the HSIP process can make large strides in alignment with the Safe System approach. The opportunity to encourage local planning efforts that align with the Safe System approach can help supplement investments in Safe System at the Federal and State levels, and help States achieve their safety performance targets and long-term safety goals.

Federal, State, and local partners responsible for roadway safety can consider the following questions, where applicable, to identify State-specific opportunities to move towards a Safe System:

[90] Texas Transportation Researcher, *Two Decades of Super 2 Research and Implementation for TxDOT Continue to Produce Benefits*, retrieved from https://tti.tamu.edu/researcher/two-decades-of-super-2-research-and-implementation-for-txdot-continues-to-produce-benefits/.

- How can our HSIP process be better aligned with the Safe System approach?
- How can we support a shift in countermeasure research, prioritization, and funding to better align with the Safe System approach?
- Are we focused on countermeasures that eliminate fatal and serious injury crashes?
- Are we focused on countermeasures that address pedestrian and bicyclist safety issues?
- Is my State or local jurisdiction focusing on how kinetic energy transfer and speed relate to crash severity?
- Are there opportunities at the local level in my State to support planning efforts that incorporate the Safe System approach?

Conclusion and Next Steps

Safe System is a relatively new concept in the United States and aligning existing safety programs will require a one-step-at-a-time collaborative approach, which will be specific to each implementing jurisdiction. This report demonstrates that while Safe System principles are currently present in many components of the State SHSP and HSIP processes, there are additional opportunities to bring these two key safety programs into further alignment with Safe System principles and elements.

Opportunities to better align the State SHSP and HSIP with Safe System principles, include but are not limited to:

SHSP

1. Organize SHSP around Safe System six core principles and five elements
2. Commit to a "zero" goal and establish performance management strategies
3. Refocus speeding emphasis area on speed management and roadway design
4. Institutionalize equity in road safety work
5. Use proactive data collection and analysis approaches to address equity considerations

HSIP

1. Research, prioritize, and fund engineering countermeasures that address Safe System elements and principles
    a. Hierarchy of Controls
    b. Primary and supporting countermeasures
    c. Beyond traditional countermeasures
    d. Prioritize research for countermeasures focused on bicycle and pedestrian safety
    e. Doubling down on countermeasures to address fatal and serious injury crashes
    f. Other project prioritization considerations
2. Assess crash severity risk using level of kinetic energy transfer and speed
3. Identify opportunities to encourage local planning efforts that align with the Safe System approach
4. Establish Safe System working groups and pilot projects

A key factor in successful implementation of a Safe System approach in existing safety programs is educating Federal and State safety engineers on Safe System. FHWA developed various marketing and outreach materials (e.g., flyer, presentation, video) that can help with education activities. Federal, State, and local safety leaders should include Safe System as part of every discussion and schedule formal opportunities to promote Safe System at various conferences and events.

A first step for States may be to assess their State SHSP and HSIP against the areas of alignment identified in this report. The questions in each chapter summary can be a useful tool to support this effort.

For many of the opportunities outlined in this report, looking beyond HSIP to address how these opportunities can be applied to other Federal and State transportation programs and projects can help to infuse an aligned Safe System approach throughout FHWA and other coordinating agencies. For example, agencies can review existing policies and procedures to align with Safe System principles. Safe System can be most effective by institutionalizing its implementation at all levels of roadway planning and engineering, and across all disciplines that have a hand in supporting roadway safety.

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Safe Roads for a Safer Future
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