

Safe System Auditing – principles to practice

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Abstract

The Safe System is a road safety philosophy that requires the road system to be designed and managed so that death and serious injury are avoidable. It consists of four core interrelated components: safer roads, safer speeds, safer vehicles, and safer people. It is a well-known principle that has been philosophically adopted by road authorities such as VicRoads. Converting the principle into action has been slower – because the natural tendency when undertaking infrastructure projects is to adopt normal practice and follow existing guidelines. Safe System Auditing is one tool being used by VicRoads to convert Safe System principles into practice. Safe System Auditing is the formal safety examination of a road related program, project or initiative. such as:

- an existing road, intersection or length,
- a road investment project, whether at feasibility, design or pre-opening stage,
- a community road safety program or funding application,
- a road transport policy or strategy.

Safe System Audits distinctly 'raise the bar' beyond the work of a Road Safety Audit (RSA). A RSA qualitatively estimates and reports on potential road safety issues against current standards and guidelines but only identifies opportunities for improvements in safety in this 'limited' perspective, however a SSA measures compliance with Safe System principles which can, and does, push outcomes to a higher level - while at the same time considering realistic constraints.

VicRoads has engaged Safe System Solutions Pty Ltd to undertake a number of Safe System Audits of infrastructure projects the results of which will be described in this paper.

Definitions

Primary Treatment: Road planning, design and management consideration that virtually eliminates the potential of fatal or serious injuries occurring in association with the foreseeable crash types.

Step Towards: Road planning, design and management considerations that improve the overall level of safety associated with foreseeable crash types, but not expected to virtually eliminate the potential of fatal or serious injuries occurring. Also, when applied to an existing road environment, they improve the ability for a Primary Treatment to be implemented in the future.

Supporting Treatments: Road planning, design and management considerations that improve the overall level of safety associated with foreseeable crash types, but not expected to virtually eliminate the potential of fatal or serious injuries occurring. Also, when applied to an existing road environment, they do not change the ability for a primary treatment to be installed in the future.

Non-Safe System Treatment: Road planning, design and management considerations that are not expected to achieve an overall improvement in the level of safety associated with foreseeable crash

types occurring, or when applied to an existing road environment, they reduce the ability for a primary treatment to be installed in the future.

Introduction

In February 2014, VicRoads approved a decision to ‘step up’ and make stronger inroads into road safety. The Safe System approach is the focus of this ‘step up’. However, it eventuated that at an operational level there was a need to provide further guidance on the constituents of the Safe System and how to integrate it into the day-to-day decisions about planning, designing, improving, maintaining and operating the Victorian road network.

There is work being undertaken at an Austroads level to integrate Safe System principles into the Road Safety Audit syllabus (ST1774). There is also a project SS1958: Development of a Safe System Assessment Framework for Infrastructure Projects, as well as SS2035: Safe System Infrastructure on Mixed Use Arterials; both of which are multi-year projects.

Safe System Audits/Assessments distinctly ‘raise the bar’ beyond the work of a Road Safety Audit. A Road Safety Audit qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in a traditional safety sense, but does not measure compliance with Safe System principles.

Infrastructure projects currently being approved for construction have varied alignment with Safe System principles. The project team’s understanding of how well or poorly their project aligns with Safe System principles varies.

The corollary of these arguments is that a multi-pronged approach is needed to imbed the Safe System into the operations of a State road agency, but in most cases there is no requirement for projects to assess their alignment with Safe System principles.

This paper proposes that, in addition to the encouragement and education currently being undertaken, that State road agencies require an independent audit/assessment of a project’s alignment with Safe System principles.

Safe System Audits/Assessments have been used in Western Australia and Victoria, and in Victoria some of the VicRoads Regions (Eastern, South Western and Metro South East) have undertaken Safe System Audits for their projects.

Similar to a Road Safety Audit, there will not be a requirement that the project team accept all recommendations from the Audit/Assessment. However, the process will ensure that the project team has considered the requirements to align with Safe System principles and will be required to justify not meeting Safe System principles.

What is the Safe System?

The Safe System is a road safety philosophy that requires roads to be designed and managed so that death and serious injury are avoidable. The basic principles are:

1. Humans are fallible, and will inevitably make mistakes when driving, riding or walking.
2. Despite this, road trauma should not be accepted as inevitable. No one should be killed or seriously injured on our roads.
3. So, to prevent serious trauma, the road system must be forgiving, so that the forces of collisions do not exceed the limits that the human body can tolerate.

The Safe System is divided into four core interrelated components:

Safer Roads	Safer Speeds
Safer Vehicles	Safer People

What is Safe System Auditing?

Using a specialist, independent and qualified team, Safe System Auditing is the formal safety examination of a road related program, project or initiative. The Safe System Audit can comprehensively assess the safety of:

- an existing road, intersection or length,
- a road investment project, whether at feasibility, design or pre-opening stage,
- a community road safety program or funding application,

Table 1 – Framework for the conduct of a Safe System Audit

Safer Roads	Safer Speeds
<p>The Safer Roads component of the Safe System Audit is similar to a Road Safety Audit, in that it is primarily concerned with the physical aspects of the roadway under investigation. However, a Safe System Audit differs because safe system principles are always at the heart of each investigation.</p> <p>This component pays specific attention to feasibility decisions such as selection of intersection type, and technical details of road and barrier design.</p> <p>Key elements that are examined include:</p> <ul style="list-style-type: none"> • Protection of vehicle occupants from roadside hazards, • Management of vehicular conflict points and angles (such as at intersections), • The “friendliness” and “compatibility” of roadside furniture in accommodating errant vehicles, • Other roadside features that influence the likelihood or consequence of a crash. 	<p>The Safer Speeds component of the Safe System Audit is primarily concerned with the setting of appropriate speed limits in accordance with safe system principles.</p> <p>This is a double edged sword in that speed limits must not contribute to severe trauma in a foreseeable crash. Yet, they need to be credible to most drivers so that their actual travel speeds are in compliance with the limit.</p> <p>Key elements that are examined include:</p> <ul style="list-style-type: none"> • Setting speed limits to prevent trauma at all times, • Designing the road environment to convey the correct speed environment to drivers at all times, • Perceptual treatments, • Variable speed limit treatments based on time-of-day.

Safer Vehicles	Safer People
<p>The Safer Vehicles component of the Safe System Audit considers the key role vehicles have in achieving a safe system. The contribution of vehicles in a Safe System Audit become significant:</p> <ul style="list-style-type: none"> • When a particular vehicle type is highly represented on a road, either in crashes or in transport volume, e.g. on a heavy freight route, or a recreational bicycle route, • Over time, when the penetration of vehicle safety features in the fleet impact on other areas of the system, e.g. electronic stability control, or autonomous emergency braking. <p>Safe System Audits are also applicable where policy decisions are being made on whether to support or promote cutting edge vehicle technologies such as autonomous vehicles (self-driving cars).</p>	<p>The Safer People component of the Safe System Audit considers the widest range of issues and measures, including:</p> <ul style="list-style-type: none"> • Impaired driving (distractions, mobile phones, drugs, alcohol, fatigue), • Restraints wearing (seat belts and child restraints), • Speed choice, • Driver attitude and risk taking, • High risk groups, i.e. children, elderly, disabled, novice road users <p>This part of the process involves local police and community leaders as they assess and attempt to influence the compliance of people with relevant road laws. Community engagement initiatives are scrutinised so that the project has the best chance of success, by gaining strong community acceptance. To obtain the maximum safety benefits from a program, it is critical to achieve and maintain strong community acceptance to any changes as early in the process as possible</p>

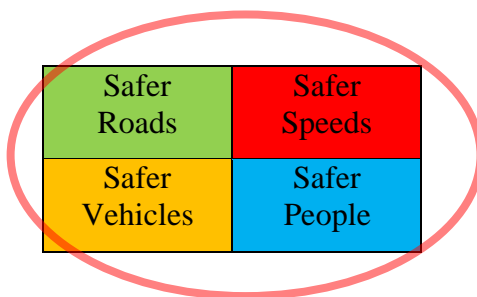
These assessments are carried out considering each of the core components of the Safe System. Table 1 shows how the Safe System Audit is conducted.

A typical consulting company, such as Safe System Solutions Pty Ltd, undertakes two types of Safe System Auditing depending on specific needs:

1. Full Safe System Auditing
2. Road and Roadside Safe System Auditing

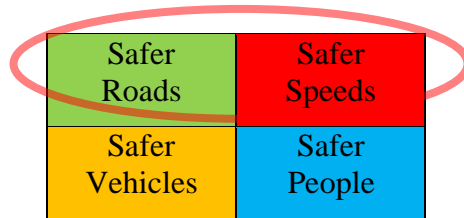
Full Safe System Auditing

Using the framework outlined above, a full Safe System Audit undertakes an in-depth investigation of all four safe system components, including the relevant road and roadside, vehicle safety and people issues. It will provide you with a holistic insight into the performance of a given road, project or programme in relation to Safe System principles.



Roads and Roadside Safe System Auditing

A **Safe System Audit for Roads and Roadside** assesses if and how existing or future roads and roadsides comply with Safe System principles. It focuses on the upper two components in the Safe System diagram, being Safer Roads and Safer Speeds.



A Roads and Roadside Safe System Audit reports its results by categorising the road and roadside treatments and features as:

1. **Primary treatments: Safe System compliant treatments or features;**
2. **Step Towards Safe System compliant treatments or features;**
3. **Safe System supporting treatments or features;** or
4. **Non-Safe System compliant treatments or features.**

The Safe System Audit provides advice on how to raise all road and roadside features into the **Primary treatments** category.

Is a Safe System Audit different to a Road Safety Audit?



The answer to the question posed by the heading of this section is: yes. Road Safety Audits (RSA) are an excellent road safety initiative, but they are not Safe System Audits. A RSA qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety, but does not measure compliance with Safe System principles.

Consider this simple example. A new project undertakes to install traffic signals at an intersection between two 60 km/h roads. Importantly, an RSA critically looks at the specific components and interactions of features of the design to ensure they don't create unexpected safety issues. However, the RSA is not designed to address the potential issue of high impact forces at the intersection.

In contrast, a Safe System Audit will address this issue and recommend ways to reduce the kinetic energy transfer rates in crashes to levels that do not result in fatal or serious injuries.

The benefits of a Safe System Audit

A Safe System Audit will provide a system manager with:

- A clear assessment of compliance with Safe System principles.
- Advice on additional measures or changes that will ensure compliance with Safe System principles.
- Independent certification of compliance with Safe System principles.

Safe System Auditing in practice

Safe System Auditing is still an emerging praxis. Safe System Solutions Pty Ltd has undertaken a number of Safe System Audits for VicRoads and the Transport Accident Commission (TAC).

Some of the key points to note for a Safe System Audit are that the audit requires a literature review, desktop study, and on-road examination. It then examines in considerable detail, not shown in this paper, the crash implications (forces) of possible crash types. In addition to intersections, the audit also examines the carriageway, roadsides, and also the implications for pedestrians, cyclists and motorcyclists.

An example of an issue identified in a Safe System Audit is associated with gaps in lengths of wire rope safety barrier (WRSB). The design in Figure 1 below shows a gap between two lengths of WRSB on a road with an 80km/h speed limit. While the run off area in this section is greater than the 'clear zone', it is not a Safe System solution. Research by the Monash University Accident Research Centre (MUARC), the Centre for Automotive Safety Research (CASR) and the Australian Road Research Board (ARRB) show that the concept of a clear zone is not by itself a Safe System solution. The research shows that, on a high speed road, to achieve a Safe System clear zone, it is estimated that a recovery area of more than 30 metres from the edge line would be required. This area would need to be smooth, easily traversable and free from hazards.



Figure 1: Example road design that does not meet Safe System principles

The other non-Safe System feature of the design clip in Figure 1 is the ability for a head on crash to occur at 80km/h (which exceeds what is considered acceptable under a Safe System (70km/h)).

These elements would be identified in a Safe System Audit, with practical advice to the project manager on how to design and install features that align with Safe System principles.

Another example of an issue identified in a Safe System Audit can be seen in Figure 2 below. An at-grade intersection in an 80km/h speed zone. While controlled by traffic signals, the energy associated with a crash at these angles and speeds far exceeds those accepted as ‘Safe System’. The Safe System Audit undertaken for this intersection used the Kinetic Energy Management Model (KEMM) produced by MUARC in 2010 to determine acceptable speeds to align with Safe System principles. The summary table from the KEMM can be seen in Table 2 below.

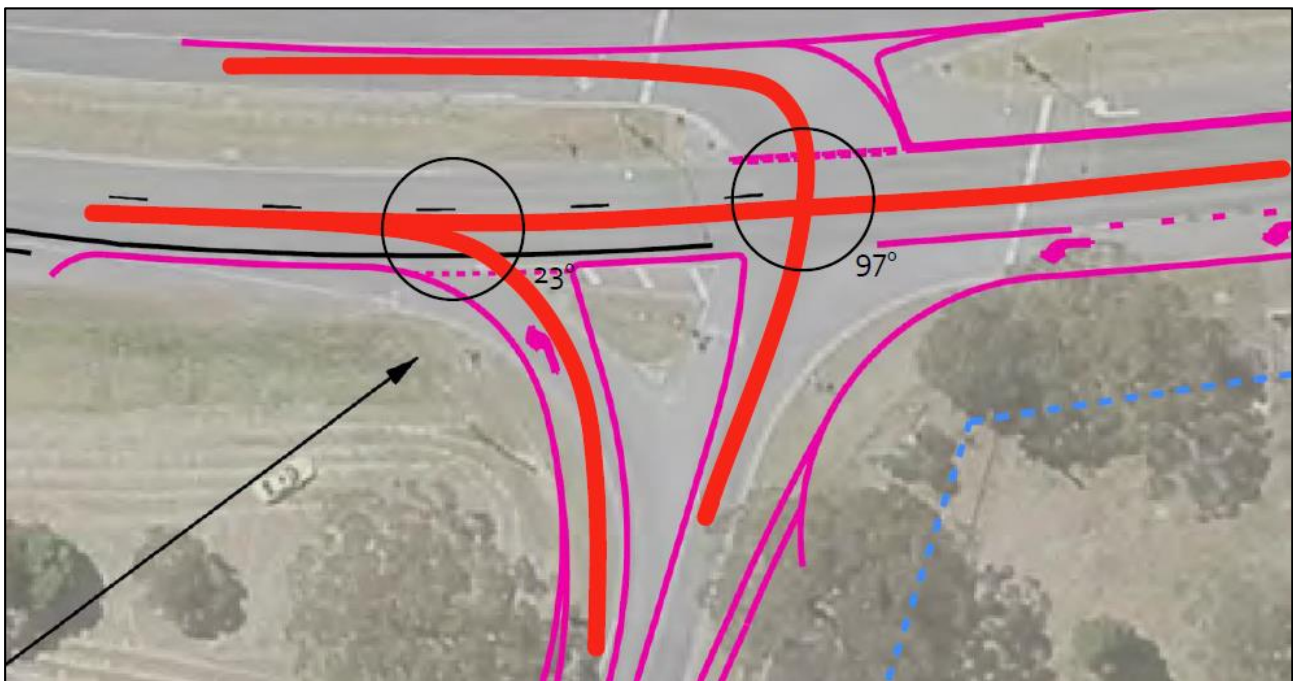


Figure 2: Example an intersection that does not meet Safe System principles

Table 2: MUARC 2010, Acceptable speeds and angles to achieve Safe System for vehicle to vehicle collisions.

Maximum impact speed (km/h)	Maximum acceptable conflict angle
40 and below	All OK
50	90°
60	52°/128° (from KEMM-X)
70	0°/180°
80 and above	None feasible

NOTE: 0° and 180° in the above table indicate a head-on and rear-end collision respectively.

Conclusion

Safe System Auditing can play a useful role in improving safety outcomes on roads and roadsides. It forms a useful supplement to Road Safety Auditing and it is expected that, in the long term, Road Safety Audits will be superseded by Safe System Audits for infrastructure projects. Thus, in the short to medium term, there exists a requirement to train practitioners on the fundamentals and process of Safe System Audits/Assessments. This will expand the pool of Safe System Auditors and continue to imbed Safe System principles into the industry.