Safe System Findings Explanation and Example

Auditors need to focus on 3 key elements when applying Safe System principles to the road safety audit process:

- Crash Severity;
- Crash exposure; and
- Crash Likelihood

Crash Severity

Auditors when applying the road safety audit process should provide emphasis to any road safety audit findings that have the potential to result in fatal or serious injury.

Austroads guidelines and the National and State Road Safety Strategies provide direction about the crash types, where the chances of surviving a crash decrease rapidly above certain impact speeds, depending on the nature of the crash.

- Head-on crashes > 70 km/h;
- Right-angle crashes > 50 km/h;
- Run off road impact object crashes > 40 km/h; and
- Crashes involving vulnerable road users > 30 km/h

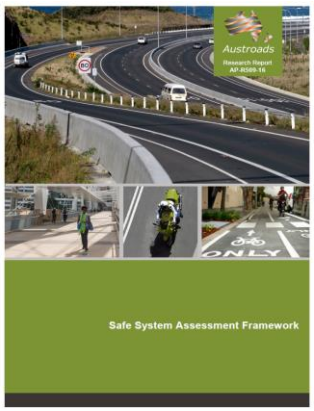
This is applied by providing the additional annotation "**IMPORTANT**" to any finding that has the potential to result fatal or serious injury, using the crash types and associated speeds provided. This provides a more scientific approach to determining findings with the potential to result in a KSI crash outcome.

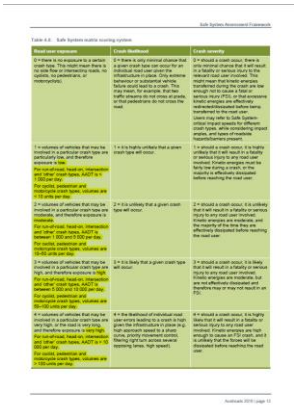
Crash Exposure

The next element auditors need to consider when you identify a finding with a potential KSI crash outcome that is deemed "**IMPORTANT**" is crash exposure.

For the application of crash exposure the revised audit process has adopted the crash exposure volume ranges provided in the *Austroads Safe System Assessment Framework*, which defines Crash exposure as: road users in what numbers and for how long are using the road and are thus exposed to a potential crash.

For the application of crash exposure auditors should refer the road user number ranges provided in Table 4.4 in the *Austroads Safe System Assessment Framework*.





The level of Crash exposure identified is categorised as either '**LOW**' '**MODERATE**' '**HIGH**' or '**VERY HIGH**'.

Crash Likelihood

The final element auditors need to consider for all findings with a potential KSI crash outcome deemed "**IMPORTANT**" is the overall level of Crash Likelihood.

This is defined in the Austroads Safe System Assessment Framework as: a group of factors affecting the probability of crash occurring, including issues such as the level of intersection control, speed, sight distance, geometric alignment, driver guidance and warning.

This should be considered by auditors by applying their road safety engineering experience, using the category of crash exposure identified in the previous step as a starting point and then consider various other aspects of each findings location to determine the overall level of Crash Likelihood.

This can either be the same, higher or lower than the level of crash exposure identified in the previous step. With the overall crash likelihood defined as either '**LOW**' '**MODERATE**' '**HIGH**' or '**VERY HIGH**'

This annotation is then displayed next to the additional annotation "**IMPORTANT**" on applicable road safety audit findings.

E.g. [**IMPORTANT** | **MODERATE**]

Safe System Finding Example

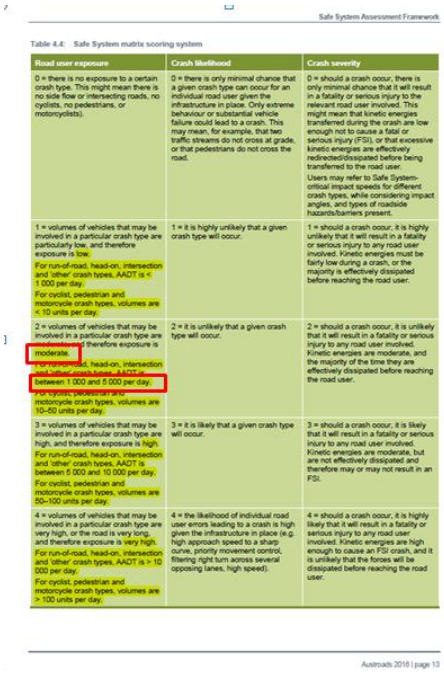
The photograph below shows an example of a site at an intersection with restricted Safe Intersection Sight Distance (SISD) on a road with a 110 km/h speed limit.

Crash Severity

This location has a right angle crash risk with a potential impact speed far in excess of > 50 km/h, hence it is a Safe System finding and it should have the additional annotation "**IMPORTANT**" associated with the finding.

Crash Exposure

The traffic volume at the site is 3500 vehicles per day and when referring to Table 4.4 of the *Austroads Safe System Assessment Framework* we can see that the level of exposure is found to be "**MODERATE**"



Safe System Assessment Framework

Table 4.4: Safe System matrix scoring system

Road user exposure	Crash likelihood	Crash severity
0 = there is no exposure to a certain crash type. This might mean there is no side flow or intersecting roads, no cyclists, no pedestrians, or motorcyclists).	0 = there is only minimal chance that a given crash type can occur for an individual road user given the infrastructure in place. Only extreme behaviour or substantial vehicle failure could lead to a crash. This may mean, for example, that two traffic streams do not cross at grade, or that pedestrians do not cross the road.	0 = should a crash occur, there is only minimal chance that it will result in a fatality or serious injury to the relevant road user involved. This might mean that kinetic energies transferred during the crash are low enough not to cause a fatal or serious injury (FSI), or that excessive kinetic energies are effectively redirected/dissipated before being transferred to the road user. Users may refer to Safe System-critical impact speeds for different crash types, while considering impact angles, and types of roadside hazards/barriers present.
1 = volumes of vehicles that may be involved in a particular crash type are particularly low, and therefore exposure is low. For run-of-road, head-on, intersection and 'other' crash types, AADT is < 1 000 per day. For cyclist, pedestrian and motorcycle crash types, volumes are < 10 units per day.	1 = it is highly unlikely that a given crash type will occur.	1 = should a crash occur, it is highly unlikely that it will result in a fatality or serious injury to any road user involved. Kinetic energies must be fairly low during a crash, or the majority is effectively dissipated before reaching the road user.
2 = volumes of vehicles that may be involved in a particular crash type are moderate, and therefore exposure is moderate. For run-of-road, head-on, intersection and 'other' crash types, AADT is between 1 000 and 5 000 per day. For cyclist, pedestrian and motorcycle crash types, volumes are 10–50 units per day.	2 = it is unlikely that a given crash type will occur.	2 = should a crash occur, it is unlikely that it will result in a fatality or serious injury to any road user involved. Kinetic energies are moderate, and the majority of the time they are effectively dissipated before reaching the road user.
3 = volumes of vehicles that may be involved in a particular crash type are high, and therefore exposure is high. For run-of-road, head-on, intersection and 'other' crash types, AADT is between 5 000 and 10 000 per day. For cyclist, pedestrian and motorcycle crash types, volumes are 50–100 units per day.	3 = it is likely that a given crash type will occur.	3 = should a crash occur, it is likely that it will result in a fatality or serious injury to any road user involved. Kinetic energies are moderate, but are not effectively dissipated and therefore may or may not result in an FSI.
4 = volumes of vehicles that may be involved in a particular crash type are very high, or the road is very long, and therefore exposure is very high. For run-of-road, head-on, intersection and 'other' crash types, AADT is > 10 000 per day. For cyclist, pedestrian and motorcycle crash types, volumes are > 100 units per day.	4 = the likelihood of individual road user errors leading to a crash is high given the infrastructure in place (e.g. high approach speed to a sharp curve, priority movement control, filtering right turn across several opposing lanes, high speed).	4 = should a crash occur, it is highly likely that it will result in a fatality or serious injury to any road user involved. Kinetic energies are high enough to cause an FSI crash, and it is unlikely that the forces will be dissipated before reaching the road user.

Crash Likelihood

Auditors then need to apply their road safety engineering experience to determine the overall crash likelihood using the level of exposure identified in the previous step as a starting point.

Remember, the overall crash likelihood can be either the same, lower or higher than the level of crash exposure identified in the previous step.

Examples of reasons an auditor may elect to increase the "**MODERATE**" exposure level to "**HIGH**" or even "**VERY HIGH**" overall Crash Likelihood in this example could include:

- a high traffic volume entering from the side road;
- a right angle crash history; or
- the intersection may be located on a crest or curve with severely restricting sight lines.

If none of these conditions exist, the auditor may decide to leave the overall crash likelihood as '**MODERATE**'.

Alternatively, an example where an auditor may elect to reduce the level from "**MODERATE**" exposure level to "**LOW**" overall Crash Likelihood in this example could include:

- a very low traffic volume entering from the side road with no crash history.

A risk assessment approach has been adopted that includes exposure, likelihood and severity. The Safe System approach has helped practitioners understand that exposure and severity are both important considerations in fatal and serious crash outcomes. However, likelihood (which was perhaps the main issue considered prior to Safe System thinking) has often been overlooked. All elements are important. As indicated below, elimination of exposure or likelihood or severity will mean that fatal and serious outcomes will be eliminated.

Exposure, likelihood and severity (the rows of the matrix) are defined as follows:

- **Road user exposure:** this refers to which road users, in what numbers and for how long are using the road and are thus exposed to a potential crash. The measures of exposure include: AADT, side-road traffic volumes, number of motorcycles, cyclists and pedestrians crossing or walking along the road, length of the road, area and length of time.
- **Crash likelihood:** groups of factors affecting the probability of a crash occurring. They can be elements which moderate opportunity for conflict (e.g. number of conflict points, offset to roadside hazards, separation between opposing traffic). They can also include elements of road user behaviour and/or road environment. Typically, these are the elements which moderate road user error rates. This includes issues such as level of intersection control (e.g. priority/signals/movement ban), speed, sight distance, geometric alignment, driver guidance and warning. and maintenance (change in practice; implications of timing).
- **Crash severity:** groups of factors affecting the probability of severe injury outcomes should a crash occur. Typically, these factors are associated with the amount of kinetic energy and its transfer in the crash, e.g. impact speeds and angles, severity of roadside hazards.

The matrix columns show the following major crash types:

- run-off-road (also referred to as ‘loss of control’, or ‘off path on curve/straight’)
- head-on (or ‘vehicles from opposing directions’)
- intersection (‘vehicles from adjacent directions’)
- other (this incorporates all same direction, manoeuvring, overtaking, on path and miscellaneous crashes)
- pedestrian
- cyclist
- motorcyclist.

These crash types represent the main crash and road user types that contribute to death and serious injury. They are included as an element of the matrix to help concentrate thinking on crash causes and solutions. They are also provided in this way to ensure that vulnerable road users are directly considered.

Pedestrian, cyclist and motorcyclist crashes are separated to highlight the special focus on vulnerable road users. Note that in some circumstances (depending on the purpose of the assessment) other columns may also be added for specific crash types if these are of high importance (e.g. heavy vehicles).

As already discussed in Section 4.3, the additional Safe System components have been included to help meet the objective that each Safe System pillar be included. Note that post-crash care has been added as a pillar. This forms a pillar of the global road safety action plan through the United Nations (WHO 2011). In the infrastructure context there are sometimes measures that can be taken to facilitate quicker emergency response times, including access to the crash scene, thereby improving safety outcomes.

Examples of how this matrix might be applied are provided in Section 4.5. Depending on the purpose of the assessment, the process may simply require application of this matrix as a way to guide thinking, and document likely Safe System outcomes for a project. However, it is likely that in many cases solutions will be required to improve safety. A draft treatment hierarchy and selection process is outlined in Section 4.6.

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